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**LAKE MARY ROAD**
CA PFH 81-1(1)

Inyo National Forest, Mono County, California

**FINAL PAVEMENT REPORT**
**April 14, 2004**

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## 1. INTRODUCTION

The Lake Mary Road project is a 2.7-mile two-lane roadway between the Horseshoe Lake parking area and the Twin Lakes Loop Road in the Inyo National Forest just west of Mammoth Lakes, California (Figure 1). Mammoth Lakes is approximately 168 miles south of Reno, Nevada. The Federal Highway Administration (FHWA) is performing project development activities for the repair, restoration and rehabilitation (3R) of Lake Mary Road.

The road is currently a 22-foot wide double lane road without paved shoulders in poor condition. Maintenance costs and time are becoming prohibitive for this road segment. There are four likely rehabilitation alternatives: (1) full-depth recycling, re-compacting and overlaying, (2) removing the existing pavement, importing new base and overlaying, (3) removing the existing pavement and placing full depth asphalt on natural materials, and (4) milling the top 2 inches of the existing asphalt and overlaying 2 inches of HACP. The pavement investigation was designed and performed with the intent of evaluating the rehabilitation alternatives. Additionally, potential roadway bench widening options were evaluated.

## 2. INVESTIGATION

### *Fieldwork*

In October 2003, a pavement and subgrade soil investigation was completed along Lake Mary Road. Seven exploratory boreholes were drilled in the roadway to investigate pavement conditions and thicknesses. Locations of the borings are illustrated in Figures 1 through 5. The boreholes ranged from 2.5 to 10.5 feet deep and were located approximately 0.4 to 0.5 mile between boreholes. Boring logs are provided in Appendix B. Graphic diagrams of materials encountered with depth are illustrated in Figures 2 through 5. It should be noted that although the vertical scale in the graphic diagrams is accurate, the borehole elevations have not been estimated. The boreholes were drilled with a truck-mounted rotary drill and 4-inch diameter solid stem augers. Samples were collected from both standard penetration tests (SPT) and bulk cuttings. Each borehole was backfilled with cuttings and cold patched.

Six additional pavement cores were collected between the borehole locations. The cores were collected with a water flushed 6-inch diameter core barrel.

A test pit was excavated near MP 1.4 (see Appendix C, Photo 8). A total of 100 lbs of pavement, base and sub-base bulk samples were collected. The excavation was backfilled with imported structural fill and cold patched.

A pavement distress survey was performed in accordance with SHRP-P-338 "Distress Identification Manual for the Long-Term Pavement Performance Project".

### *Laboratory Testing*

All samples were shipped to Denver in sealed 5-gallon plastic buckets. Laboratory index and strength tests have been performed on SPT and bulk samples of base, fill and native soils. Index testing was performed at the Yeh and Associates, Inc. laboratory and the R-value testing was performed at Professional Service Industries, Inc. (PSI), both AASHTO accredited laboratories. The tests performed and the standards followed are given in Table 1.

**Table 1. Laboratory test standards.**

| Test | Standard |
|---|---|
| Gradation analysis | AASHTO T27 |
| Atterberg Limits | AASHTO T89 and T90 |
| Moisture Content | AASHTO T265 |
| Classification | AASHTO M145 and ASTM D2487 |
| R-value | AASHTO T190 |
| pH | AASHTO T289 |
| Soluble Sulfate Content | AASHTO T290 |

## 3. EXISTING CONDITIONS

### *Climate*

Mammoth Lakes has a semi arid mountain climate that is unusually mild for an alpine region. Average temperature highs in the winter are in the 30's; and in the summer, the upper 70's. Average winter lows are in the teens; and in the summer, the 40's. Fall in the Eastern Sierra is typified by a change in color in the deciduous flora, with Mammoth's first freeze usually occurring by late September. Relevant climate statistics are given in Table 2.

**Table 2. Climate statistics.**

| | Monthly Range | Annual |
|---|---|---|
| Average maximum temperature (°F) | 53.8-97.2 | 73.9 |
| Average minimum temperature (°F) | 21.7-55.9 | 37.8 |
| Average temperature (°F) | 37.8-76.6 | 55.9 |
| Average rainfall (inches) | .1-1.0 | 5.4 |

Source: worldclimate.com

### *Existing Roadway Template*

The existing roadway width varies from 22 to 24 feet wide. Unpaved shoulder widths outside of pavement are generally three to ten feet wide. The existing embankment sections are generally able to support the desired width of 26 feet paved roadway and 32 feet improved foreslopes without modification of the alignment. The existing narrow sections are generally in cut locations where the combined shoulder and ditch width between the edge of pavement and the toe of the cut varies from one to four feet. The slope of the shoulders/bench must generally match that of the mainline.

### *Existing Pavement*

The pavement is generally in poor condition with moderate severity transverse, block, and fatigue cracking, with sections of significant edge raveling. Crack sealing is now required on a yearly basis and the road has become a financial burden for the Forest Service to maintain. The results of the pavement distress survey are summarized in Table 3. A summary of pavement thickness is given in Table 4.

**Table 3. Pavement distress survey summary.**

| Mile Marker (miles) | Paved Road Width (feet) | Pavement Thickness (inches) | Road Base Thickness (inches) | Pavement Condition |
|---|---|---|---|---|
| 0.0 to 0.1 | ~22 | 4.00 | 6.0 | Low to moderate longitudinal and transverse cracking. Patched areas. Moderate to high edge cracking; failure of EOP. |
| 0.1 to 0.4 | ~24 | 4.27 (2.5 @ pullout) | 6.0-8.0 | Low to moderate longitudinal and transverse cracking. Moderate to high severity raveling - 2 feet by 2 feet. Moderate to high edge cracking; failure of EOP. Patched edge areas present. Paved pull-out area with patching. |
| 0.4 to 1.0 | ~22 | 4.00 to 4.27 | 6.0-8.0 | Low to moderate longitudinal and transverse cracking. Moderate to high edge cracking. Moderate to high fatigue cracking. Low to moderate potholes. |
| 1.0 to 1.5 | ~22 | 4.27 to 5.00 | 9.0 | Low to moderate longitudinal cracking. Low to moderate edge cracking. Polished aggregate. Low to moderate potholes. |
| 1.5 to 2.0 | ~22 | 3.69 to 5.00 | 6.0- 7.0 | Low to moderate longitudinal and transverse cracking. Moderate to high edge cracking. Moderate to high severity raveling - 4 feet by 6 feet. Low to moderate potholes. |
| 2.0 to 2.7 | ~22 | 4.35 to 4.50 | 6.0-12.0 | Low to moderate longitudinal and transverse cracking. Low to moderate reflection cracking. Low to moderate edge cracking. Low potholes. |

**Table 4. Pavement thickness summary.**

| Borehole or Core | Mile Marker (miles) | Asphalt Thickness (inches) | Base Course Thickness (inches) |
|---|---|---|---|
| P-1 | 0.0 | 4.00 | 6.0 |
| C-1 | 0.2 | 4.30 | |
| P-2 (pullout) | 0.4 | 2.50 | 6.0 to 8.0 |
| C-2 | 0.7 | 4.00 | |
| P-3 | 0.9 | 4.00 | 6.0 to 8.0 |
| C-3 | 1.1 | 4.30 | |
| P-4 | 1.3 | 5.00 | 9.0 |
| Test Pit | 1.5 | 4.00 | 10.0 |
| C-4 | 1.5 | 4.40 | |
| P-5 | 1.8 | 5.00 | 7.0 |
| C-5 | 2.0 | 3.70 | |
| P-6 | 2.3 | 4.50 | 6.0 |
| C-6 | 2.6 | 4.40 | |
| P-7 | 2.7 | 4.50 | 12.0 |

***Subsurface***

In general, the subgrade consists of well-compacted road base to approximately 1-foot depth. The underlying glacial colluvium or colluvial fill was encountered to the maximum depth of exploration, approximately 10.5 feet. Bedrock was not encountered in the borings, but was observed in some of the cut slopes along the project. Ground water was not encountered during our drilling operations.

*Road Base*

Road base material generally consists of sand with some silt and gravel that classifies as A-1-b according to the AASHTO classification system (SP-SM by USCS). As shown in Table 4 above, the thickness of this layer ranges from 6 to 12 inches, averaging 8 inches. This unit is difficult to

distinguish from the natural on-site materials and may be a compacted and reworked section of in-situ materials.

*Glacial Colluvial Soils*
This layer was encountered in all of the bore holes. It generally consists of loose to medium dense silty sand with variable amounts of gravel and courser cobbles and boulders. Deposits along the road include moraines made of bouldery glacial till and spreading alluvial fans of glacial outwash. Ultimately, this soil is derived from granitic rocks of the Sierra Nevada batholith and volcanic rocks from the Long Valley caldera.

*Bedrock*
Rhyolite and rhyolitic tuffs from the Long Valley caldera is exposed in the existing cut and natural slopes, but was not encountered in the exploratory borings. This formation consists of various rhyolitic lithologies. In some locations, there are compositions of tuffaceous diatomaceous earth that has extremely low density and is hydrothermally altered. Regionally, the project area is located in Owens Valley in the westernmost part of the Basin and Range province of eastern California. The Mammoth Lakes area is an active volcanic region with earthquakes and emissions of carbon dioxide. Lake Mary Road lies along the southwestern margin of the Long Valley caldera, a 10-mile by 20-mile topographic depression.

*Fill Embankments*
Current embankment fills generally consist of riprap or boulder and cobble material taken off the cut construction along the route. This fill material is difficult to distinguish from the natural colluvial materials and may be one in the same. The fill slopes are generally in good condition, with no observed surficial or deep-seated movement noted. The base material is natural colluvial materials that are well-draining with minimal long-term settlement expected. Additional embankment construction is not expected as part of the roadway improvements.

*Glacial Colluvium Cut Slopes*
The natural slopes are approximately 1-1/2H:1V and are probably near the angle of repose of the colluvial material. As recommended in the scoping report, future cuts, if needed, should be less than 34 degrees (estimated colluvial material internal friction angle) to ensure long-term global stability. Precipitation and frost-heave processes may be responsible for surface raveling, which should be taken into account in future cut areas by the use of a wider shoulder or catchment ditch.

Table 5 below summarizes the material properties that were encountered during our exploratory drilling investigation. For R-value testing, samples were combined that had the same AASHTO classification. Samples from P-1, P-2 and P-3 from a depth of 1 to 4 feet were all classified as A-2-4 (0) by the AASHTO classification system. P-5 and P-7 at depth of 1 to 4 feet classified as A-1-b (0) by AASHTO classification system, and therefore combined for R-value testing.

**Table 5. Laboratory test results summary**

| Sample | | | Natural Moisture Content (%) | Gradation (USCS) | | | Atterberg Limits | | | pH | Water Soluble Sulfate (%) | Resistivity (Ω-cm) | R-Value | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring No. | Depth (m) | Blow Count | | Gravel > #4 (%) | Sand (%) | Fines < #200 (%) | LL | PL | PI | | | | | AASHTO | USCS |
| P-1 | 1 | 21 | 6.6 | | | | | | | | | | | | |
| P-1 | 4 | 3 | 11.1 | | | | | | | | | | | | |
| P-1 | 1-4 | | 8.0 | 6 | 66 | 28 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-1 | 9 | 47 | | | | | | | | 7.1 | 0.002 | | | | |
| P-2 | 1 | 8 | 10.4 | | | | | | | | | | | | |
| P-2 | 4 | 22 | 5.6 | | | | | | | | | | | | |
| P-2 | 1-4 | | 9.8 | 12 | 67 | 21 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-3 | 1 | 19 | 9.7 | | | | | | | | | | | | |
| P-3 | 4 | 50 for 5.5" | 7.0 | | | | | | | 7.9 | 0.002 | | | | |
| P-3 | 1-4 | | 5.7 | 42 | 29 | 29 | NV | NP | NP | | | | | A-2-4(0) | GM |
| P-4 | 1 | 22 | 7.8 | | | | | | | | | | | | |
| P-4 | 4 | 9 | 14.5 | | | | | | | | | | | | |
| P-4 | 1-4 | | 6.7 | 39 | 50 | 11 | NV | NP | NP | | | | | A-1-a (0) | SP-SM |
| P-5 | 1 | 50 for 0" | 7.0 | | | | | | | | | | | | |
| P-5 | 1-4 | | 6.0 | 26 | 57 | 17 | NV | NP | NP | | | | | A-1-b (0) | SM |
| P-6 | 1.5 | R | 8.6 | 11 | 57 | 32 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-7 | 1.5 | 54 | 6.2 | | | | | | | | | | | | |
| P-7 | 4 | 18 | | | | | | | | 6.9 | 0.002 | | | | |
| P-7 | 1-4 | | 8.2 | 19 | 69 | 12 | NV | NP | NP | | | 70420 | | A-1-b(0) | SP-SM |
| Base Course | | | 10.8 | 28 | 66 | 6 | NV | NP | NP | | | | 75 | A-1-b(0) | SP-SM |
| P-1 & P-2 & P-3 | 1-4 | | | | | | | | | | | | 66 | | |
| P-4 | 1-4 | | | | | | | | | | | | 68 | | |
| P-5 & P-7 | 1-4 | | | | | | | | | | | | 68 | | |

### *Corrosion Potential*

Representative samples of soil and bedrock were tested for pH, resistivity, and water soluble sulfates to evaluate their corrosion potential for culvert pipes. Table 6 gives the ranges of the measured values for these parameters.

**Table 6. Corrosion parameters**

| Corrosion Parameter | Range |
|---|---|
| pH | 6.9-7.9 |
| Resistivity (Ω-cm) | 70,420 + |
| Sulfates (%) | <0.01 |

Based on the laboratory test results, the general characteristics of the soils at the tested locations indicate a negligible degree of pH and sulfate attacks on concrete exposed to these materials. The soil resistivity results shown in Table 6 were considered virtually non aggressive toward iron and buried metals.

### *Seismicity*

Lake Mary Road is located in a seismically active area. According to the USGS 1996 Seismic Hazard Map, the project site has a peak horizontal acceleration of 0.40g with a 10% probability of exceedance in 50 years. The nearest active faults are the Hilton Fault, approximately 25 miles west, and an unnamed fault south of Deadman Creek, approximately 10 miles north of the site.

In 1980, a series of four earthquakes centered in Mammoth Lakes, with magnitudes of 6.0 or greater and more than 200 aftershocks of magnitude 3.0 or greater triggered several thousand landslides throughout this area. With the site, no landslides were observed (USGS, 1984).

At the beginning of the project area, at the Horseshoe Lake parking lot, there is an area where trees have been killed by carbon dioxide poisoning. This is an indication that magma lies below the surface and is venting carbon dioxide at a rate of approximately 1,300 tons of $CO_2$ per day (Sharp, 1997). It is unclear if these venting gases may effect the development of a pavement section in this area. There may be pockets of $CO_2$ in the subsurface that may affect the density of the subgrade materials.

## 4. ANALYSIS

### *Roadway Width*

The existing roadway template is expected to accommodate the 26 feet that will be needed for the planned pavement widening.

### *Traffic Volume*

Based on appendix material from the Lake Mary Road Bicycle Lanes investigation pertaining to the determination of the traffic index, the 20-year design period total 18 kip ESAL is estimated to be 46,000. For design purposes, this value was used for the project area.

### *Pavement Section*

The following options have been evaluated:

Option 1. Full depth recycle the existing asphalt, moisture treat and compact to 95% Modified Proctor density, then overlay with 3 inches of HACP. This option would use the existing materials on site. The grade would be 3 inches higher than the existing roadway elevation.

Option 2. Remove the existing asphalt, import aggregate base material, then overlay 3 inches of

HACP. Two nearby source areas for aggregate have already been investigated as part of the scoping report. This section would match the recommendation for the other section of roadway leading up to the project area from the town of Mammoth Lakes. Waste material would have to be disposed off site. More rigorous grade control will be required (staking and survey), but the existing roadway elevation would remain the same.

Option 3. Remove the existing asphalt, then place full-depth HACP directly on native materials. This option may save the cost and time of importing materials, but the roadway elevation would be lowered. Additionally, waste material would have to be disposed off site. More rigorous grade control will be required (staking and survey).

Option 4. Mill off 2 inches of the existing asphalt, then overlay 2 inches of HACP. This is not a long-term solution to improving the performance of this roadway. Additionally, the edge cracking problems could continue.

The pavement design parameters used to evaluate the four options described above are given in Table 7. The structural coefficients were determined from the AASHTO guidelines with recommendations by the FHWA Central Federal Lands Highway Division. The DARWin pavement design program was used to analyze each option. It is recommended to not place less than 3-inch of HACP on an unbound material; therefore, a minimum structural number (SN) of 1.5 was selected for the design SN. In some cases, the calculated required SN was lower than the design SN due to this minimum HACP thickness.

**Table 7. Pavement design parameters.**

| Option | Design HACP Thickness (inches) | Design Base Thickness (inches) | Design RAP Thickness (inches) | Design Subgrade R-Value | Existing HACP Structural Coefficient | Base Structural Coefficient | HACP Structural Coefficient | RAP Structural Coefficient |
|---|---|---|---|---|---|---|---|---|
| 1 | 3 | N/A | 5 | 66 | N/A | N/A | 0.44 | 0.12 |
| 2 | 3 | 6 | N/A | 66 | N/A | 0.14 | 0.44 | N/A |
| 3 | 4 | N/A | N/A | 66 | N/A | N/A | 0.44 | N/A |
| 4 | 2 | N/A | N/A | N/A | 0.25 | N/A | 0.44 | N/A |

- Design Reliability = 75%
- Initial serviceability = 4.2
- Terminal serviceability = 2.0
- Design Standard Deviation = 0.49
- 18-kip EASL = 46,000

## 5. COST ANALYSIS

The four pavement options described above in the pavement analysis section were evaluated for initial construction costs using the pavement design software DARWin based on the following cost assumptions:

- HACP unit cost = $40/ton
- Liquid asphalt unit cost = $250/ton
- Milling unit cost = $1.50/yd$^2$
- Full Depth Reclamation = $0.30/ft$^2$
- Aggregate Base = $13/ ton

The calculations are given in Appendix E and the results are summarized in Table 8. These costs are for comparison purposes only. Maintenance costs for options 1, 2, and 3 are expected to be the same. However, option 4 will have higher maintenance costs due to the reflective cracking from edge, fatigue, and transverse cracks on the existing pavement.

**Table 8. Pavement Initial Construction Costs**

| Pavement Option | Performance Life (years) | Estimated Initial Construction Cost (per mile) |
|---|---|---|
| 1 | 20 | $178,035 |
| 2 | 20 | $215,550 |
| 3 | 20 | $201,827 |
| 4 | 20 | $110,594 |

## 6. RECOMMENDATONS

### *Pavement Section*

Based on the initial construction costs of the options considered, we believe that the optimum engineering solution for this roadway is Option 1. Out of the long-term solutions (option 1, 2, and 3), option 1 has the lowest estimated initial construction cost per mile. Re-using the existing asphalt and road base will result in no hauling or disposal fees. Additional borrow material will not need to be imported to the site. Although the initial construction costs for only milling and overlaying the top 2 inches of the existing asphalt has the lowest costs, we believe that it will not provide a long-term solution to the pavement distress that was observed on site.

- As recommended by Caltrans District 9, the HACP should be a Type A mix with PBA-6a asphalt cement grade. Quantity can be estimated at 6% by weight of mix. The unit weight can be estimated at 145 $lb/ft^3$.
- A prime coat should be applied on the pulverized base material prior to paving. The material should be an MC-70 cutback (at .33$gallon/yd^2$) and an item for blotter material should be included (at 1.638 $lb/ft^2$).
- Tack coat (at .10 $gallons/yd^2$) is required and should either be a CSS-1, CSS-1h, SS-1, or SS-1h emulsion.

Based on the information provided by Inyo National Forest Service, the nearest asphalt plant producing the Caltrans specified asphalt cement grade would be Desert Aggregate. It is located in Leevining and approximately 40 miles away from the project site.

### *Fills and Excavations*

Any temporary excavations in colluvial fill or soil should be sloped at no steeper than 1-1/2:1. Any permanent fills should be well compacted and sloped at no steeper than 2:1.

No areas requiring subexcavation were observed. Surface water should be contained by drainage ditches. Cut slope areas may require wider ditches or other precautions to contain higher surface water flow.

## 7. LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from exploratory borings, field reconnaissance and the proposed type of construction. The nature and extent of subsurface variations across the site may not become evident until excavation is performed. If during construction, fill, soil, or water conditions appear to be different from those described herein, this office should be advised at once so reevaluation of the recommendations may be made. We recommend on-site observation of excavations and foundation bearing strata by a representative of the geotechnical engineer.

Respectfully Submitted,

YEH AND ASSOCIATES, INC.

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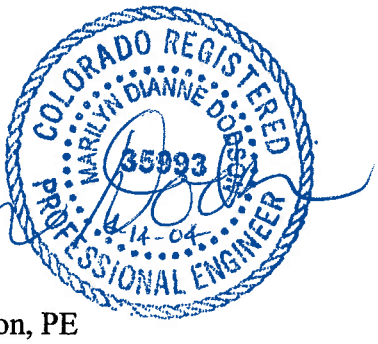
Reviewed by:




Marilyn Dodson, PE

## 8. REFERENCES


AASHTO, 1993, AASHTO Guide for the Design of Pavement Structures.

Alt, D. and Hyndman, D., 2000, Roadside Geology of Northern and Central California, Mountain Press Publishing Company, Missoula, MT, 369p.

Colorado Department of Transportation (CDOT), 2003, 2004 Pavement Design Manual.

FHWA, 2001, Basic Asphalt Recycling Manual, publication NHI01-22.

FHWA Central Federal Lands Highway Division, Statement of Work, Lake Mary Road CA PFH 81-1(1), August 29, 2003.

FHWA Central Federal Lands Highway Division, Geotechnical Scoping Report, Lake Mary Road CA PFH 81-1(1), February 5, 2003.

Jennings, C.W., 1975, Fault Map of California with Locations of Volcanoes, Thermal Springs, and Thermal Wells, California Geologic Data Map Series, scale 1:750,000.

Jennings, C.W., 1977, Geologic Map of California, California Geologic Data Map Series, scale 1:750,000.

Sharp, P. and Glazner, A., 1997, Geology Underfoot in Death Valley and Owens Valley, Mountain Press Publishing Company, Missoula, MT, 321p.

Strategic Highway Research Program, 1993, Distress Identification Manual for the Long-Term Pavement Performance Project, SHRP-P-338, Washington, DC.

United States Geological Survey (USGS), 1982, Surface Ruptures, Mammoth Lakes, California, Earthquakes, May 1980, USGS Map MF-1396, scale 1:24,000.

USGS, 1984, Landslides from the May 25-27, 1980, Mammoth Lakes, California, Earthquake Sequence, USGS Map I-1612, scale 1:62,000.

USGS, 1996, Seismic Hazard Map, http://geohazards.cr.usgs.gov/eq/.

Wirtgen, 2001, Wirtgen Cold Recycling Manual, 2nd Revision, Windhagen, Germany, ISBN 3-936215-00-6.

# APPENDICES

A – Figures

B- Boring Logs

C – Photographs

D –Laboratory Test Results

E- Pavement Design Analysis

# APPENDIX A

File Server:Public Files/2003 Project/23-077 Lake Mary's Rd/DWG/Eng_Geo_Sheets.dwg

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Sheet Revision

| Date | Revision/Issue | Checked by |
|---|---|---|
| | | |
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| | | |

For: **Mammoth Lakes State Park**

Project Number: **23-077**

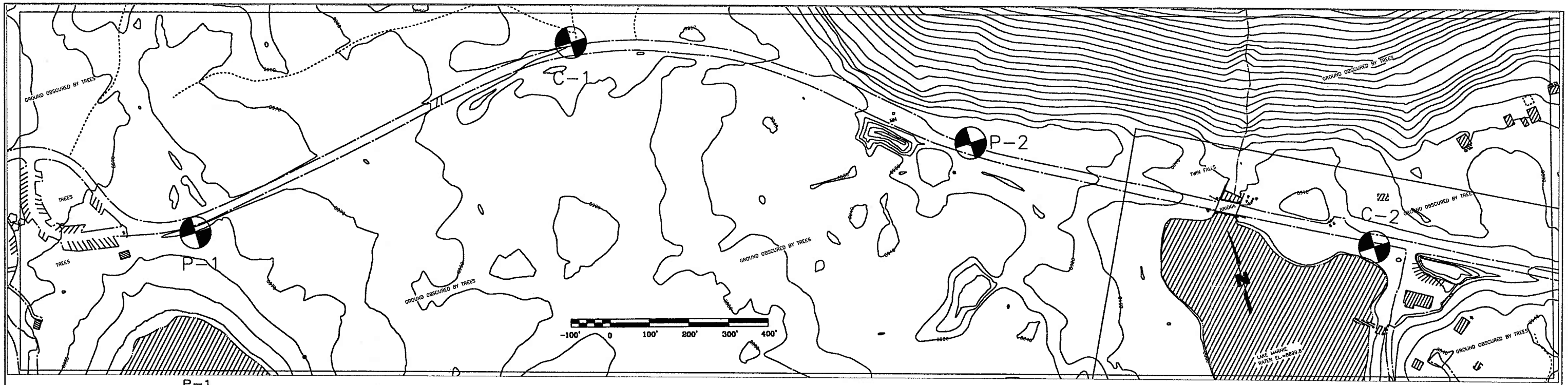
Drawn by: **KJS** Date: **December 2003**

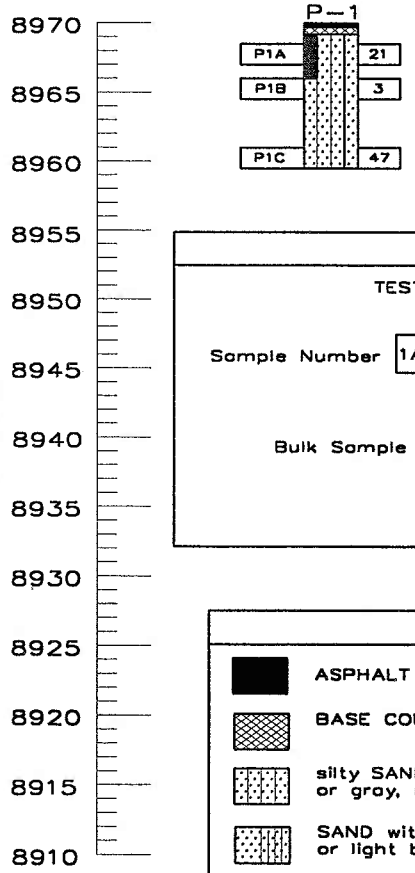
Checked by: **MDD**

# Boring Location Plan

Project: **Lake Mary's Road**

Figure Number: **1**







## LEGEND

TEST BORING

Sample Number 1A 30 — Blows per Foot *
R = Refusal (Bounce)

Bulk Sample

Approximate Location of Test Boring

* Standard Penetration Test (AASHTO T 206-87(2000))

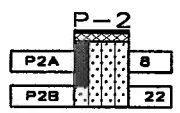
## TYPE OF MATERIAL

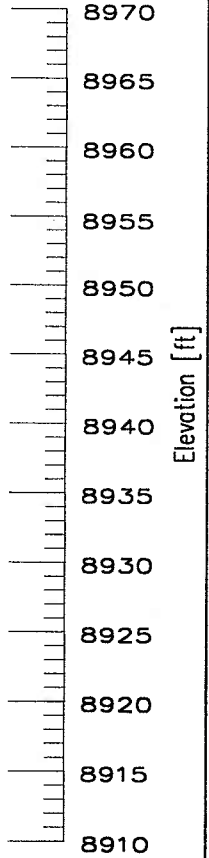
- ASPHALT
- BASE COURSE - SAND with some silt and gravel, SP-SM
- silty SAND with trace gravel, SM, reddish borwn, yellowish brown, tan or gray, moist, loose to medium dense
- SAND with some silt and gravel, SP-SM, tan, reddish brown, brown or light brown, moist, loose to medium dense
- silty GRAVEL with sand(29%), GM, tan to yelowish-brown, moist, medium dense

## SUMMARY OF TEST RESULTS

| Sample No. | Depth | Classification | Natural Moisture % | Sieve Analysis USCS Gravel >#10 | Sand | Fines< #200 | Atterberg Limits Liquid Limit | Plastic Limit | Plastic Index | pH | Swell % | USCS* Classification | AASHTO Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P1A | 1-2.5' | | 7 | | | | | | | | | | |
| P1B | 4-5.5' | | 11 | | | | | | | | | | |
| P1C | 9-10.5' | | | | | | | | | 7.1 | 0.002 | | |
| P-1 BULK | 1-4' | silty SAND with trace gravel | 8 | 6 | 66 | 28 | NP | NP | NP | | | SM | A-2-4(0) |
| P2A | 1-1.5' | | 10 | | | | | | | | | | |
| P2B | 4-5.5' | | 6 | | | | | | | | | | |
| P-2 BULK | 1-4' | silty SAND with trace gravel | 10 | 12 | 67 | 21 | NP | NP | NP | | | SM | A-2-4(0) |

*visual classification





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Sheet Revision

| Date | Revision/Issue | Checked by |
|---|---|---|
| | | |

For: Carter & Burgess, Inc.

Project Number: 23-077

Drawn by: KJS

Checked by: MDD

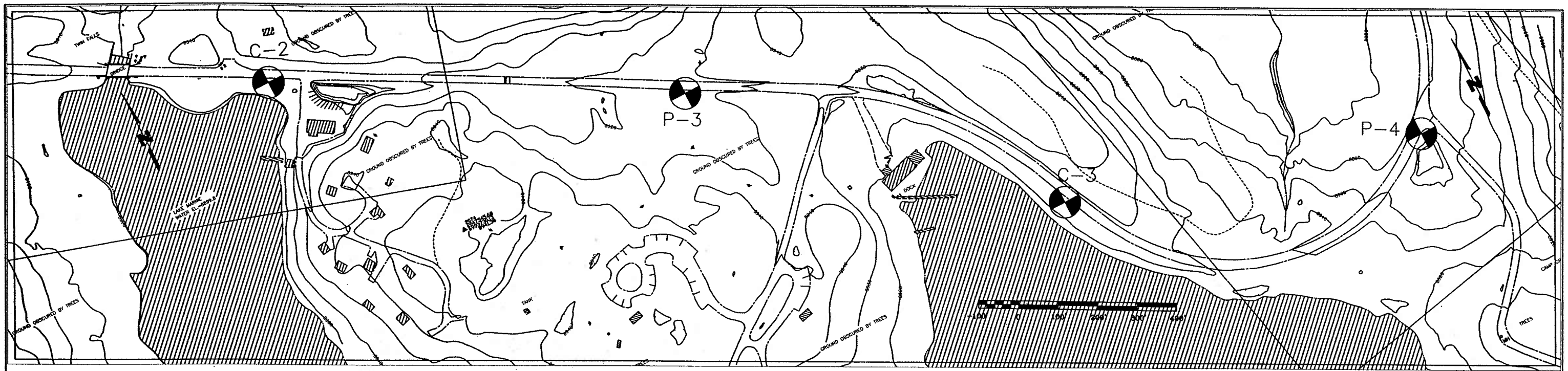
Date: December 2003

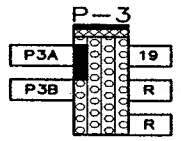
# Boring Location Plan

Project: Lake Mary's Road

Figure Number: 2

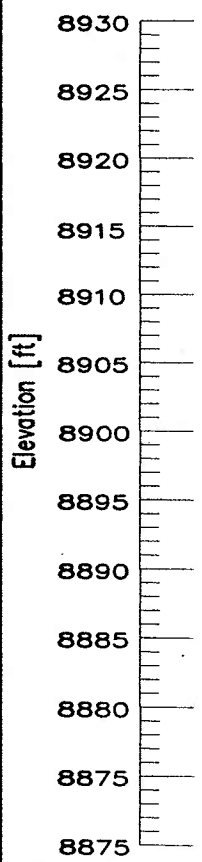
File Server:Public Files/2003 Project/23-077 Lake Mary's Rd/DWG/Eng_Geo_Sheets_Fig_2+3.dwg

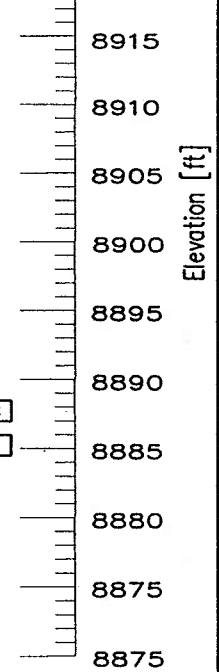


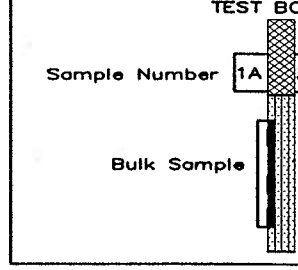

## TYPE OF MATERIAL

- ASPHALT
- BASE COURSE – SAND with some silt and gravel, SP–SM
- silty SAND with trace gravel, SM, reddish borwn, yellowish brown, tan or gray, moist, loose to medium dense
- SAND with some silt and gravel, SP–SM, tan, reddish brown, brown or light brown, moist, loose to medium dense
- silty GRAVEL with sand(29%), GM, tan to yelowish–brown, moist, medium dense



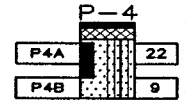

## LEGEND




Approximate Location of Test Boring

Blows per Foot *
R = Refusal (Bounce)

* Standard Penetration Test
{AASHTO T 206–87(2000)}




## SUMMARY OF TEST RESULTS

| Sample No. | Depth | Classification | Natural Moisture % | Sieve Analysis USCS | | | Atterberg Limits | | | pH | Swell % | USCS* Classification | AASHTO Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gravel >#10 | Sand | Fines< #200 | Liquid Limit | Plastic Limit | Plastic Index | | | | |
| P3A | 1.5–3' | | 10 | | | | | | | | | | |
| P3B | 4–5.5' | | 7 | | | | | | | 7.9 | 0.002 | | |
| P–3 BULK | 1.5–4' | silty GRAVEL with sand (29%) | 6 | 42 | 29 | 29 | NP | NP | NP | | | GM | A–2–4(0) |
| P4A | 1.5–3' | | 8 | | | | | | | | | | |
| P4B | 4–5.5' | | 15 | | | | | | | | | | |
| P–4 BULK | 1.5–4' | gravelly SAND with some silt | 6 | 39 | 50 | 11 | NP | NP | NP | | | SP–SM | A–1–a(0) |

*visual classification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### Sheet Revision

| Date | Revision/Issue | Checked by |
|---|---|---|
| | | |

For: Carter & Burgess, Inc.

Project Number: 23-077

Drawn by: KJS

Checked by: MDD

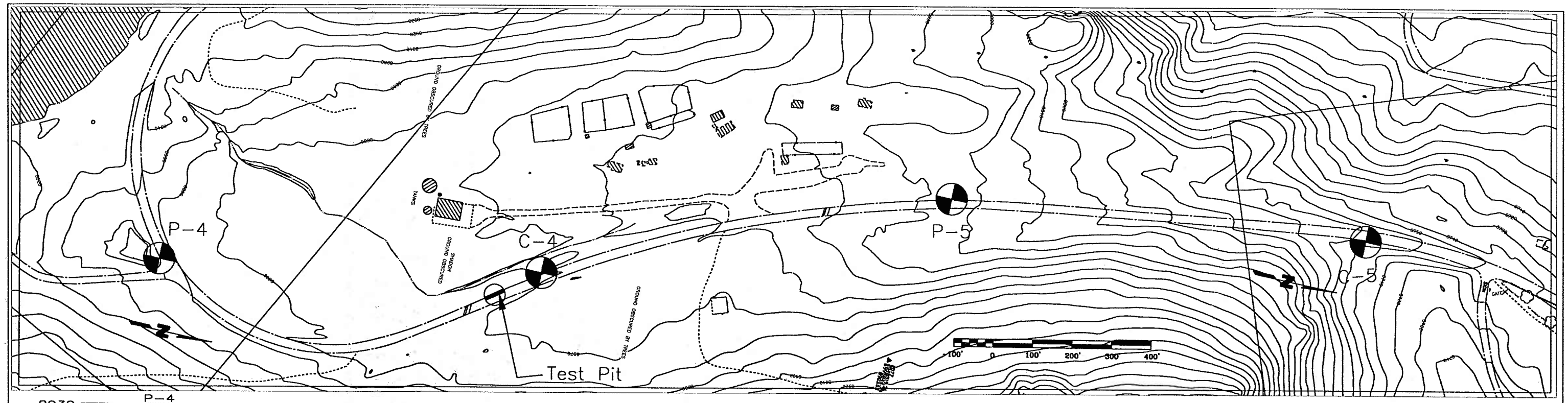
Date: December 2003

# Boring Location Plan

Project: Lake Mary's Road

Figure Number: 3

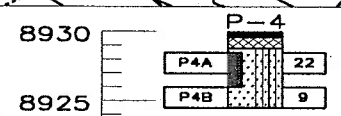
File Server:Public Files/2003 Project/23-077 Lake Mary's Rd/DWG/Eng. Geo. Sheets Fig. 2+3.dwg

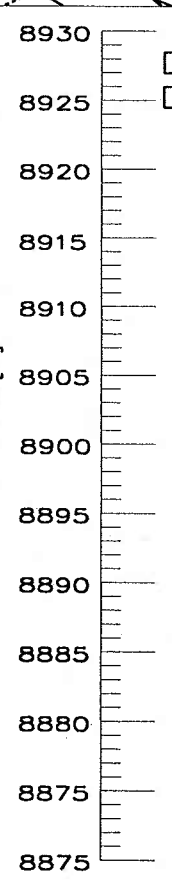


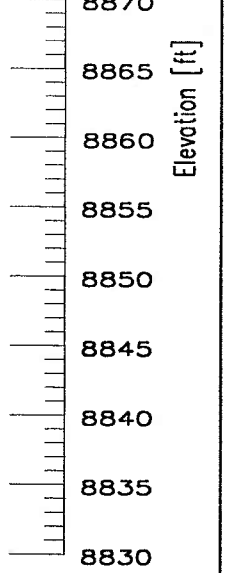

## SUMMARY OF TEST RESULTS

| Sample No. | Depth | Classification | Natural Moisture % | Sieve Analysis USCS Gravel >#10 | Sand | Fines< #200 | Atterberg Limits Liquid Limit | Plastic Limit | Plastic Index | pH | Swell % | USCS* Classification | AASHTO Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P4A | 1.5-3' | | 8 | | | | | | | | | | |
| P4B | 4-5.5' | | 15 | | | | | | | | | | |
| P-4 BULK | 1.5-4' | silty SAND with trace gravel | 6 | 39 | 50 | 11 | NP | NP | NP | | | SP-SM | A-1-a(0) |
| P5A | | | 7 | | | | | | | | | | |
| P-5 BULK | 1-3.5' | silty SAND with some gravel | 6 | 26 | 57 | 17 | NP | NP | NP | | | SM | A-1-b(0) |

*visual classification




## LEGEND

TEST BORING

Sample Number 1A 30 — Blows per Foot * R = Refusal (Bounce)

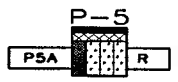
Bulk Sample

Approximate Location of Test Boring

* Standard Penetration Test (AASHTO T 206-87(2000))

## TYPE OF MATERIAL

- ASPHALT
- BASE COURSE - SAND with some silt and gravel, SP-SM
- silty SAND with trace gravel, SM, reddish borwn, yellowish brown, tan or gray, moist, loose to medium dense
- SAND with some silt and gravel, SP-SM, tan, reddish brown, brown or light brown, moist, loose to medium dense
- silty GRAVEL with sand(29%), GM, tan to yelowish-brown, moist, medium dense

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| | | |
| | | |

For: **Carter & Burgess, Inc.**

Project Number: **23-077**

Drawn by: **KJS** Date: **December 2003**

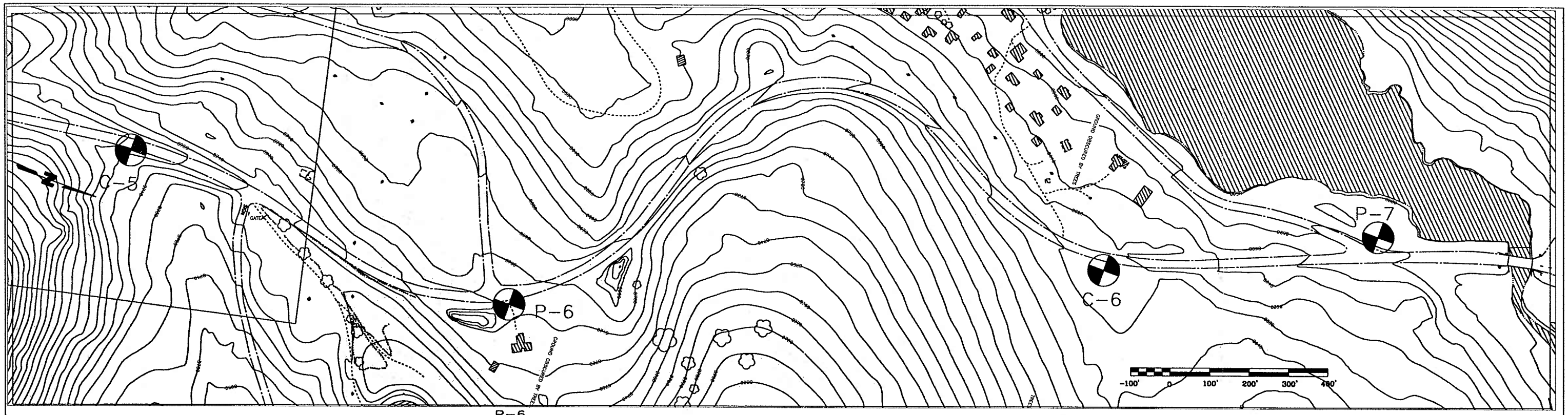
Checked by: **MDD**

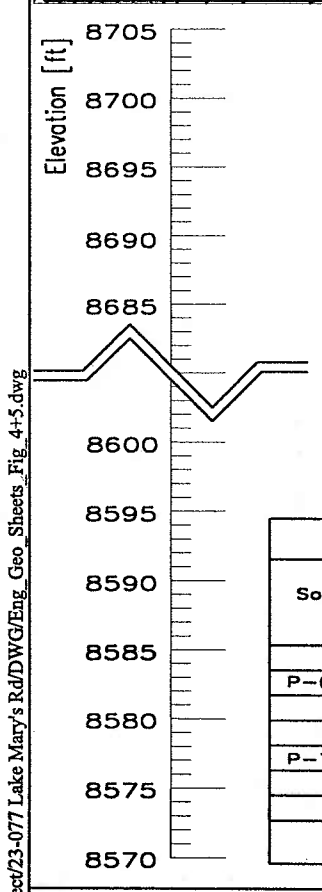
# Boring Location Plan

Project: **Lake Mary's Road**

Figure Number: **4**

File Server:Public Files/2003 Project/23-077 Lake Mary's Rd/DWG/Eng_Geo_Sheets_Fig_4+5.dwg



## TYPE OF MATERIAL

- ASPHALT
- BASE COURSE – SAND with some silt and gravel, SP–SM
- silty SAND with trace gravel, SM, reddish borwn, yellowish brown, tan or gray, moist, loose to medium dense
- SAND with some silt and gravel, SP–SM, tan, reddish brown, brown or light brown, moist, loose to medium dense
- silty GRAVEL with sand(29%), GM, tan to yelowish–brown, moist, medium dense

## LEGEND

TEST BORING

Approximate Location of Test Boring

Sample Number 1A 30 Blows per Foot *
R = Refusal (Bounce)

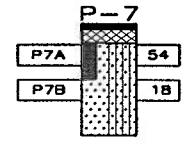
Bulk Sample

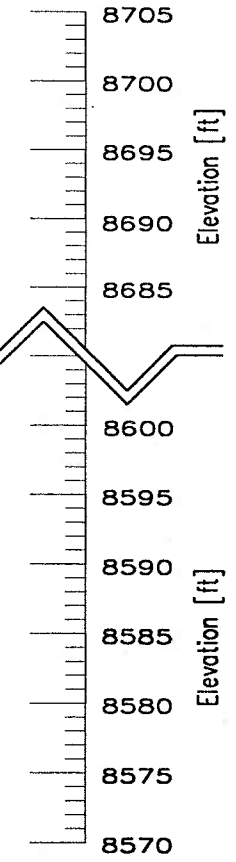
* Standard Penetration Test
(AASHTO T 206–87(2000))

## SUMMARY OF TEST RESULTS

| Sample No. | Depth | Classification | Natural Moisture % | Sieve Analysis USCS Gravel >#10 | Sand | Fines< #200 | Atterberg Limits Liquid Limit | Plastic Limit | Plastic Index | pH | Swell % | USCS* Classification | AASHTO Classification |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P6A | 1.5–2.5' | | 9 | | | | | | | | | | |
| P–6 BULK | 1.5–2.5' | silty SAND with trace gravel | 11 | 57 | 32 | | NP | NP | NP | | | SM | A–2–4(0) |
| P7A | 1.5–3' | | 8 | | | | | | | | | | |
| P7B | 4–5.5' | | 8 | | | | | | | 6.9 | 0.002 | | |
| P–7 BULK | 1.5–4' | silty SAND with trace gravel | 6 | 19 | 69 | 12 | NP | NP | NP | | | | |

*visual classification





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**Sheet Revision**

| Date | Revision/Issue | Checked by |
|---|---|---|
| | | |

For: **Carter & Burgess, Inc.**

Project Number: **23-077**

Drawn by: **KJS** Date: **December 2003**

Checked by: **MDD**

# Boring Location Plan

Project: **Lake Mary's Road**

Figure Number: **5**

File Server:Public Files/2003 Project/23-077 Lake Mary's Rd/DWG/Eng_Geo_Sheets_Fig_4+5.dwg

# APPENDIX B

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-1**
Sheet 1 of 1

Boring Began:
Drilling Method: Solid-Stem Auger
Drill:
Driller: Crux
Logged By: Nordine
Final By:
Inclination: Vertical

Completed:
Drill Bit:
Casing:
Weather:

Total Depth: 10.5 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.3 ft.** Asphalt (4"). | |
| | | | | | | | | **0.3 - 0.8 ft. SAND** with some silt and gravel, SP-SM, (base course: 6"). | |
| | | | | | | | | **0.8 - 4.0 ft. silty SAND** with trace gravel, SM, brown, moist, medium dense, calcareous. | MC= 7 % |
| | | | | | 11/13/8 | 21 | | | bulk sample 1'-4', 6% gravel, 66% sand, 28% fines, non-plastic<br>MC= 8 %<br>AASHTO: A-2-4(0)<br>USCS: SM |
| | 5 | | | | 2/2/1 | 3 | | **4.0 - 5.5 ft.** very loose. | MC= 11 %<br>driller noted caving @ 5' |
| | | | | | | | | **5.5 - 9.0 ft.**. | |
| | 10 | | 11 | | 11/34/13 | 47 | | **9.0 - 10.5 ft.** medium dense. | pH= 7.1<br>S/C= 0.002 %<br>double bouncing during drive due to gravel, see 34 count |
| | | | | | | | | Bottom of Hole at 10.5 ft. | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-2**
Sheet 1 of 1

Boring Began: 10/22/2003
Completed: 10/22/2003
Total Depth: 5.5 ft
Drilling Method: Solid-Stem Auger
Drill Bit:
Ground Elevation:
Drill:
Casing:
Location: Pull out area
Driller: Crux
Weather:
Coordinates: N: E:
Logged By: Nordine/Sam
Final By:
Inclination: Vertical

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.2 ft.** Asphalt (2.5"). | |
| | | | | | | | | **0.2 - 0.8 ft. SAND** with some silt and gravel, SP-SM, (base course: 6-8"). | |
| | | | | | | | | **0.8 - 4.2 ft. silty SAND** with trace gravel, SM, reddish brown to tan, moist, loose, structure backfill. | MC= 10 % |
| | | | | | 6/5/3 | 8 | | | bulk sample 1'-4', 12% gravel, 67% sand, 21% fines, non-plastic<br>MC= 10 %<br>AASHTO: A-2-4(0)<br>USCS: SM |
| | 5 | | | | 29/9/13 | 22 | | **4.2 - 5.5 ft.** medium dense, increased gravel and cobbles. | MC= 6 % |
| | | | | | | | | Bottom of Hole at 5.5 ft. | refusal at 5.5' |
| | 10 | | | | | | | | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-3**
Sheet 1 of 1

Boring Began: 10/23/2003
Completed: 10/23/2003
Total Depth: 8.0 ft
Drilling Method:
Drill Bit:
Ground Elevation:
Drill:
Casing:
Location:
Driller: Crux
Weather:
Coordinates: N: E:
Logged By: Nordine
Final By:
Inclination: Vertical

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.3 ft.** Asphalt (4"). | |
| | | | | | | | | **0.3 - 0.9 ft. SAND** with some silt and gravel, SP-SM, (base course: 6-8"). | |
| | | | | | | | | **0.9 - 8.0 ft. silty GRAVEL** with sand (29%), GM, tan to yellowish-brown, moist, medium dense. | MC= 10 % |
| | | | | | 7/9/10 | 19 | | | driller noted cobbles @ 2' |
| | | | | | | | | | bulk sample 1.5'-4', 42% gravel, 29% sand, 29% silt, non-plastic<br>MC= 6 %<br>AASHTO: A-2-4(0)<br>USCS: GM |
| | 5 | | | | 12/25/50 for 5.5" | 50 for 5.5" | | | color chages to grey-tan<br>MC= 7 %<br>pH= 7.9<br>S/C= 0.002 % |
| | | | | | | | | Bottom of Hole at 8.0 ft. | refusal at 8' (possible boulder) |
| | 10 | | | | | | | | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-4**
Sheet 1 of 1

Boring Began: 10/22/2003
Drilling Method:
Drill:
Driller: Crux
Logged By:
Final By:
Inclination: Vertical

Completed: 10/22/2003
Drill Bit:
Casing:
Weather:

Total Depth: 5.5 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.4 ft.** Asphalt (5"). | |
| | | | | | | | | **0.4 - 1.2 ft. SAND** with some silt and gravel, SP-SM, (base course: 9"). | MC= 8 % |
| | | | | | 7/10/12 | 22 | | **1.2 - 5.5 ft. gravelly SAND** with some silt, SP-SM, reddish brown to tan, moist, loose to medium dense. | bulk sample 1.5'-4', 39% gravel, 50% sand, 11% fines, non-plastic<br>MC= 6 %<br>AASHTO: A-1-a(0)<br>USCS: SP-SM |
| | | | | | | | | | |
| | 5 | | | | 5/5/4 | 9 | | | MC= 15 % |
| | | | | | | | | Bottom of Hole at 5.5 ft. | |
| | 10 | | | | | | | | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-5**
Sheet 1 of 1

Boring Began: 10/23/2003
Completed: 10/23/2003
Total Depth: 3.5 ft
Drilling Method: Solid-Stem Auger
Drill Bit:
Ground Elevation:
Drill:
Casing:
Location:
Driller: Crux
Weather:
Coordinates: N: E:
Logged By: Nordine
Final By:
Inclination: Vertical

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.4 ft.** Asphalt (5"). | |
| | | | | | | | | **0.4 - 1.0 ft. SAND** with some silt and gravel, SP-SM, (base course: 7"). | |
| | | | | | R | R | | **1.0 - 3.5 ft. silty SAND** with some gravel, SM, brown to tan, moist, loose to medium dense. | MC= 7 %<br><br>bulk sample 1'-3.5', 26% gravel, 57% sand, 17% fines, non-plastic<br>MC= 6 %<br>AASHTO: A-1-b(0)<br>USCS: SM<br>refusal at 2' (probable boulder); moved hole 3' north of original location |
| | 5 | | | | | | | Bottom of Hole at 3.5 ft. | refusal at 3.5' at new location; driller noted big boulders |
| | 10 | | | | | | | | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

**YEH AND ASSOCIATES, INC.**
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: Lake Mary Road
Project Number: 23-077 Date: 11/24/03

Boring: **P-6**
Sheet 1 of 1

Boring Began:
Drilling Method:
Drill:
Driller: Crux
Logged By:
Final By:
Inclination: Vertical

Completed:
Drill Bit:
Casing:
Weather:

Total Depth: 2.5 ft
Ground Elevation:
Location:
Coordinates: N: E:

Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.4 ft.** Asphalt (4.5"). | |
| | | | | | | | | **0.4 - 0.9 ft. SAND** with some silt and gravel, SP-SM, (base course: 6"). | |
| | | | | | | | | **0.9 - 2.5 ft. silty SAND** with trace gravel, SM, tan to gray, loose to medium dense, boulders. | |
| | | | | | 10/12/R | R | | | bulk sample 1.5'-2.5', 11% gravel, 57% sand, 32% fines, non-plastic MC= 9 % pH= 6.7 S/C= 0.002 % AASHTO: A-2-4(0) USCS: SM refusal at 2.5' (probable boulder); moved hole 3' north; refusal at 2.5' at new location |
| | 5 | | | | | | | Bottom of Hole at 2.5 ft. | |
| | 10 | | | | | | | | |

BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

| YEH AND ASSOCIATES, INC. GEOTECHNICAL ENGINEERING CONSULTANTS | Project: Lake Mary Road<br>Project Number: 23-077 Date: 11/24/03 | Boring: **P-7**<br>Sheet 1 of 1 |
|---|---|---|

Boring Began: 10/22/2003 Completed: 10/22/2003 Total Depth: 8.0 ft
Drilling Method: Drill Bit: Ground Elevation:
Drill: Casing: Location:
Driller: Crux Weather: Coordinates: N: E:
Logged By:
Final By:
Inclination: Vertical

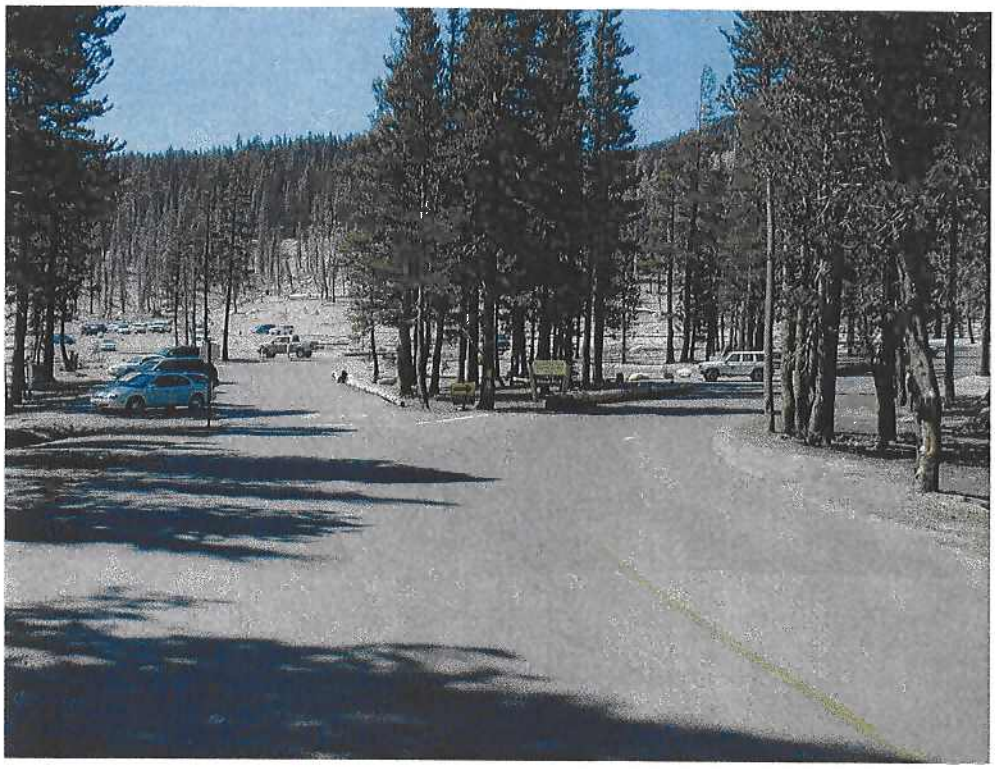
Ground Water Notes:

| | | | | |
|---|---|---|---|---|
| Depth | - | - | - | - |
| Date | - | - | - | - |
| Time | - | - | - | - |

| Elevation (feet) | Depth (feet) | Run / Sample Type | Recovery (%) | Rock RQD | Soil Samples SPT Blows per 6 in | Soil Samples N | Lithology | Material Description | Field Notes and Lab Tests |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | **0.0 - 0.4 ft.** Asphalt (4.5"). | |
| | | | | | | | | **0.4 - 1.4 ft. SAND** with some silt and gravel, SP-SM, (base course: 12"). | |
| | | | | | 13/31/23 | 54 | | **1.4 - 8.0 ft. SAND** with some silt and gravel, SP-SM, brown to light brown, moist, medium dense. | bulk sample 1.5'-4', 19% gravel, 69% sand, 12% fines, non-plastic<br>MC= 6 %<br>MC= 8 % |
| | | | | | | | | | |
| | 5 | | | | 8/10/8 | 18 | | | increased gravel @ 4'<br>pH= 6.9<br>S/C= 0.002 % |
| | | | | | | | | | |
| | | | | | R | R | | Bottom of Hole at 8.0 ft. | refusal at 8' (probable boulder) |
| | 10 | | | | | | | | |

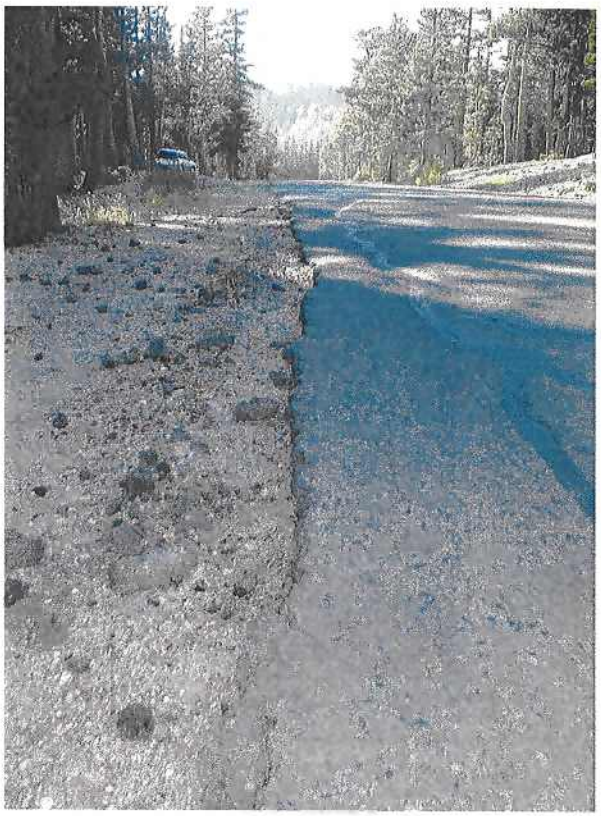
BORING LOG 23-077_LAKE_MARY_ROAD.GPJ YEH ASSOCIATES.GDT 1/12/04

# APPENDIX C



Photograph 1 (MM 0.0): Horseshoe Lake parking lot entrance.

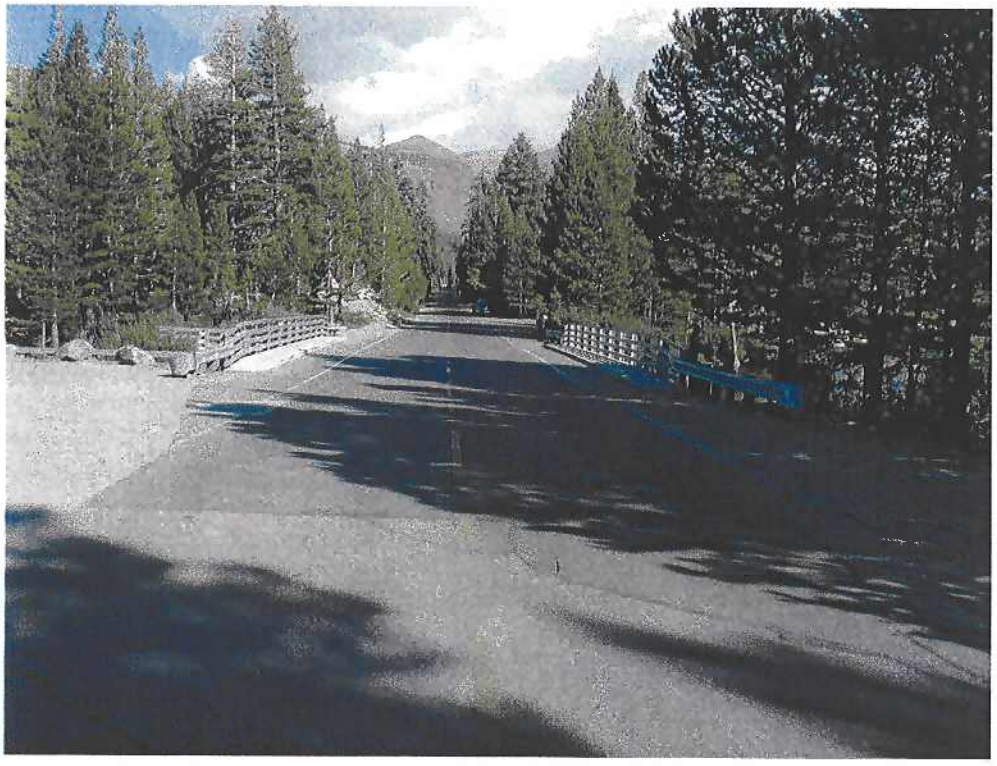
Photograph 2 (MM 0.0 to 0.1): Low to moderate patching.



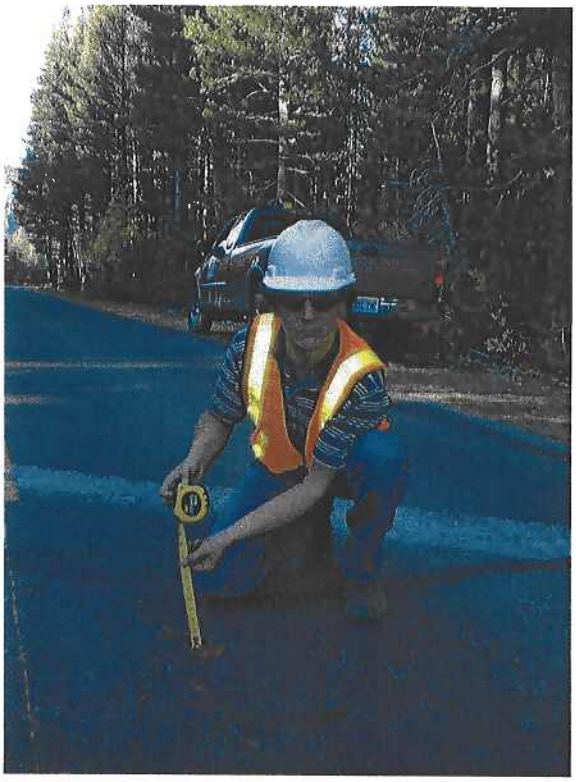
Photograph 3 (MM 0.1-0.4): Moderate to high edge cracking and EOP failure.

Photograph 4 (MM 0.4 to 1.0): Moderate to high fatigue cracking.

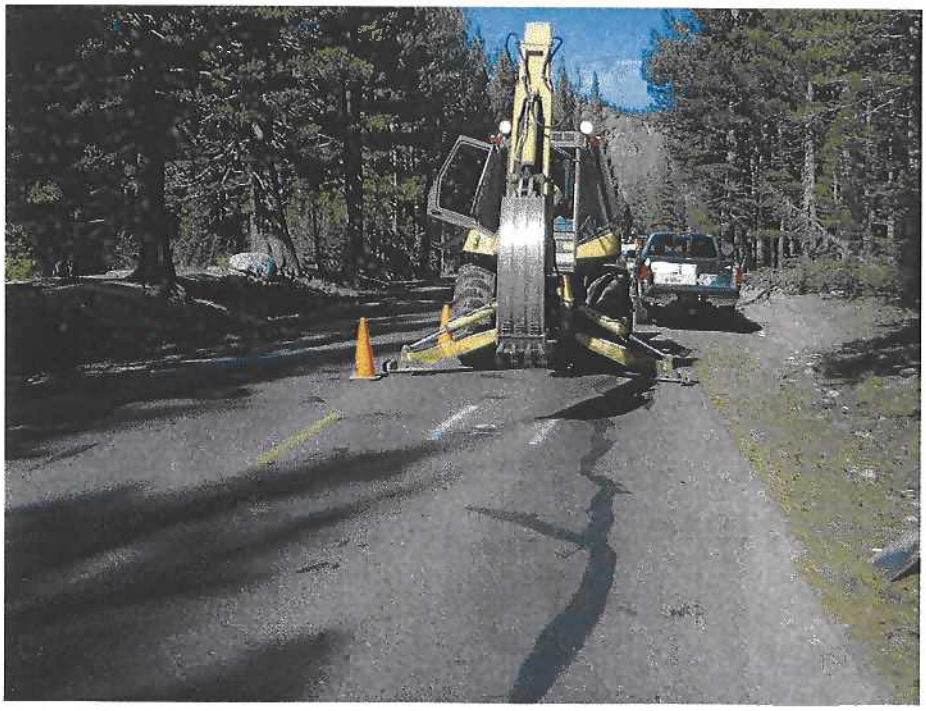
Photograph 5 (MM 0.4): Drill rig set up on P-2 on a fill section.



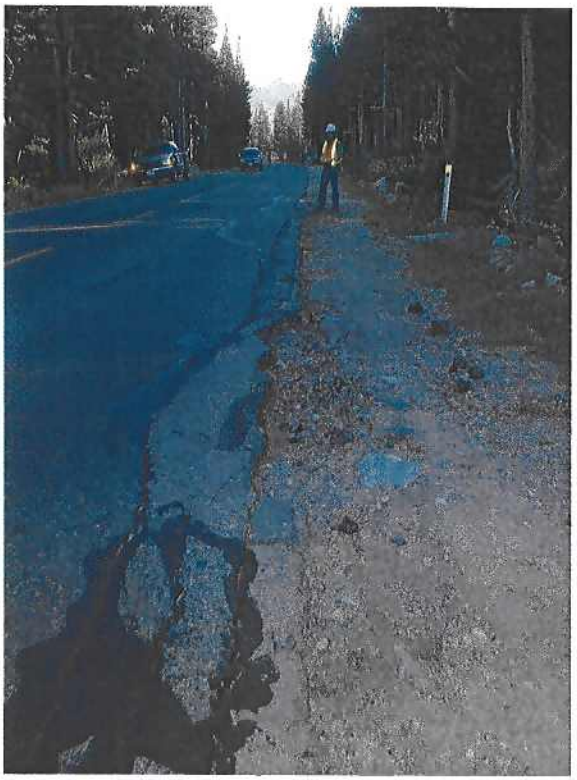
Photograph 6 (MM 0.5): Bridge at outflow of Lake Marnie.



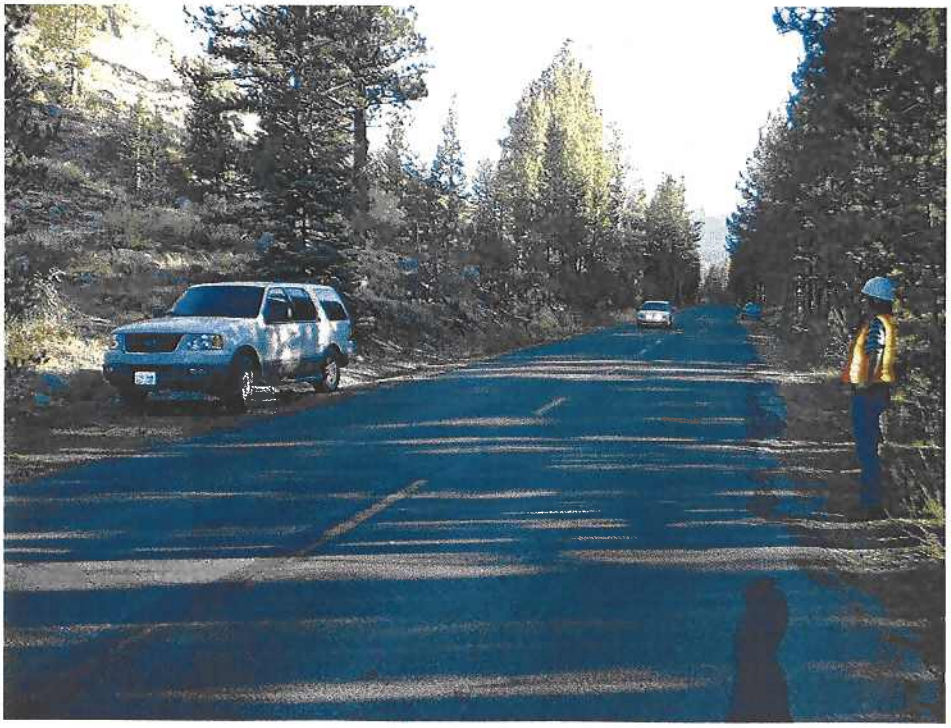
Photograph 7 (MM 1.0-1.5): Low to moderate potholes.



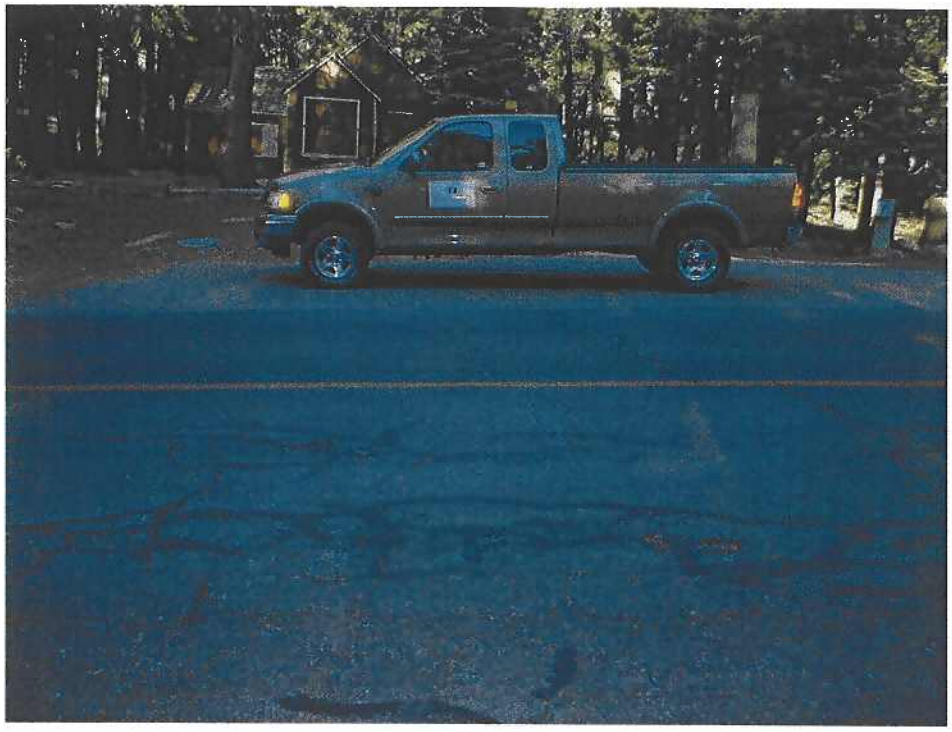
Photograph 8 (MM 1.4): Test pit excavation.



Photograph 9 (MM 1.5-2.0): Moderate to high edge cracking.



Photograph 10 (MM 1.7): Cut slope location.

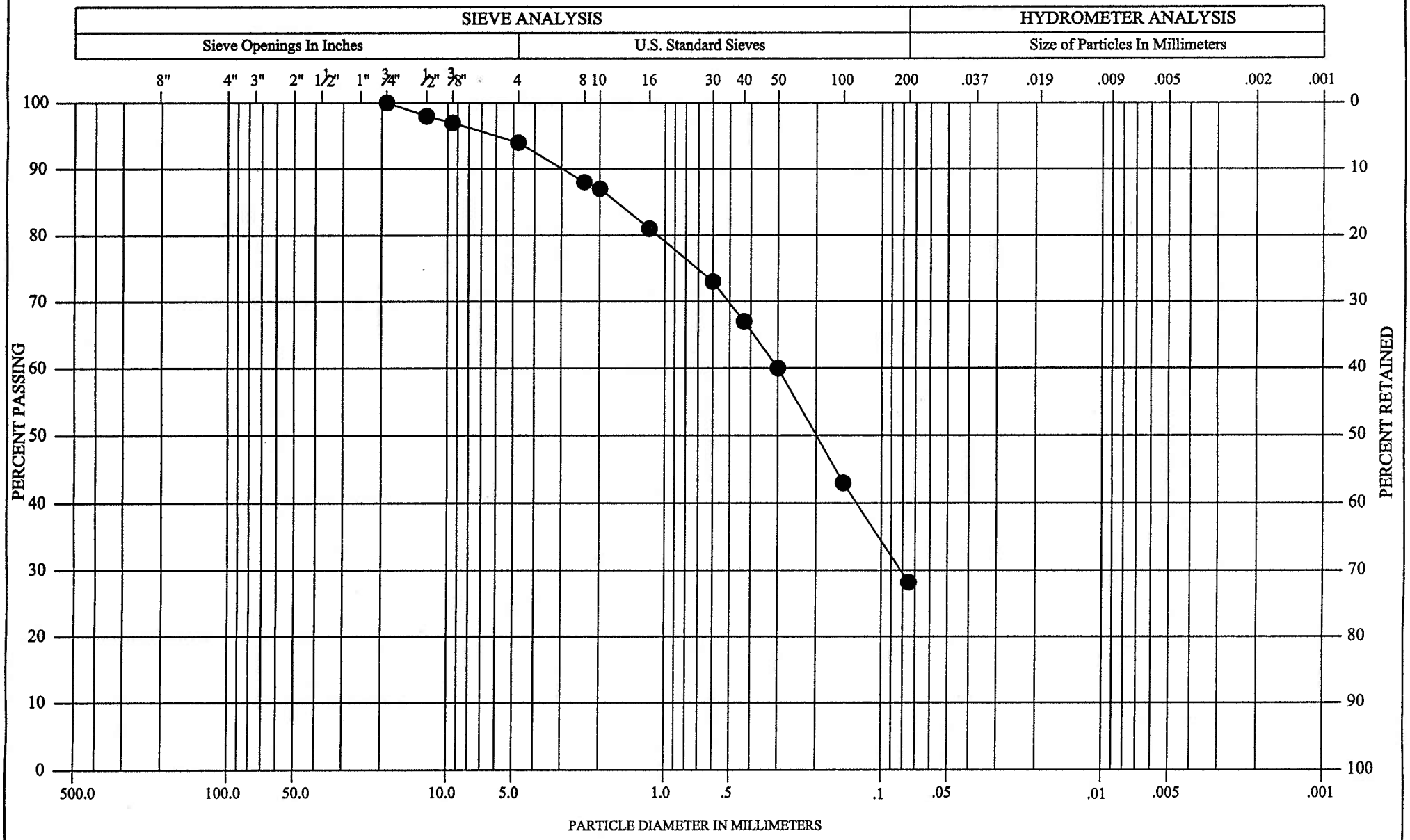


Photograph 11 (MM 2.0-2.5): Low to moderate reflection cracking.

Photograph 12 (MM 2.5): Drill rig set up on P-7.

# APPENDIX D

| Sample | | | Natural Moisture Content | Gradation (USCS) | | | Atterberg Limits | | | pH | Water Soluble Sulfate | Resistivity | R-Value | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boring No. | Depth (m) | Blow Count | (%) | Gravel > #4 (%) | Sand (%) | Fines < #200 (%) | LL | PL | PI | | (%) | (Ω-cm) | | AASHTO | USCS |
| P-1 | 1 | 21 | 6.6 | | | | | | | | | | | | |
| P-1 | 4 | 3 | 11.1 | | | | | | | | | | | | |
| P-1 | 1-4 | | 8.0 | 6 | 66 | 28 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-1 | 9 | 47 | | | | | | | | 7.1 | 0.002 | | | | |
| P-2 | 1 | 8 | 10.4 | | | | | | | | | | | | |
| P-2 | 4 | 22 | 5.6 | | | | | | | | | | | | |
| P-2 | 1-4 | | 9.8 | 12 | 67 | 21 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-3 | 1 | 19 | 9.7 | | | | | | | | | | | | |
| P-3 | 4 | 50 for 5.5" | 7.0 | | | | | | | 7.9 | 0.002 | | | | |
| P-3 | 1-4 | | 5.7 | 42 | 29 | 29 | NV | NP | NP | | | | | A-2-4(0) | GM |
| P-4 | 1 | 22 | 7.8 | | | | | | | | | | | | |
| P-4 | 4 | 9 | 14.5 | | | | | | | | | | | | |
| P-4 | 1-4 | | 6.7 | 39 | 50 | 11 | NV | NP | NP | | | | | A-1-a (0) | SP-SM |
| P-5 | 1 | 50 for 0" | 7.0 | | | | | | | | | | | | |
| P-5 | 1-4 | | 6.0 | 26 | 57 | 17 | NV | NP | NP | | | | | A-1-b (0) | SM |
| P-6 | 1.5 | R | 8.6 | 11 | 57 | 32 | NV | NP | NP | | | | | A-2-4(0) | SM |
| P-7 | 1.5 | 54 | 6.2 | | | | | | | | | | | | |
| P-7 | 4 | 18 | | | | | | | | 6.9 | 0.002 | | | | |
| P-7 | 1-4 | | 8.2 | 19 | 69 | 12 | NV | NP | NP | | | 70420 | | A-1-b(0) | SP-SM |
| Base Course | | | 10.8 | 28 | 66 | 6 | NV | NP | NP | | | | 75 | A-1-b(0) | SP-SM |
| P-1 & P-2 & P-3 | 1-4 | | | | | | | | | | | | 66 | | |
| P-4 | 1-4 | | | | | | | | | | | | 68 | | |
| P-5 & P-7 | 1-4 | | | | | | | | | | | | 68 | | |



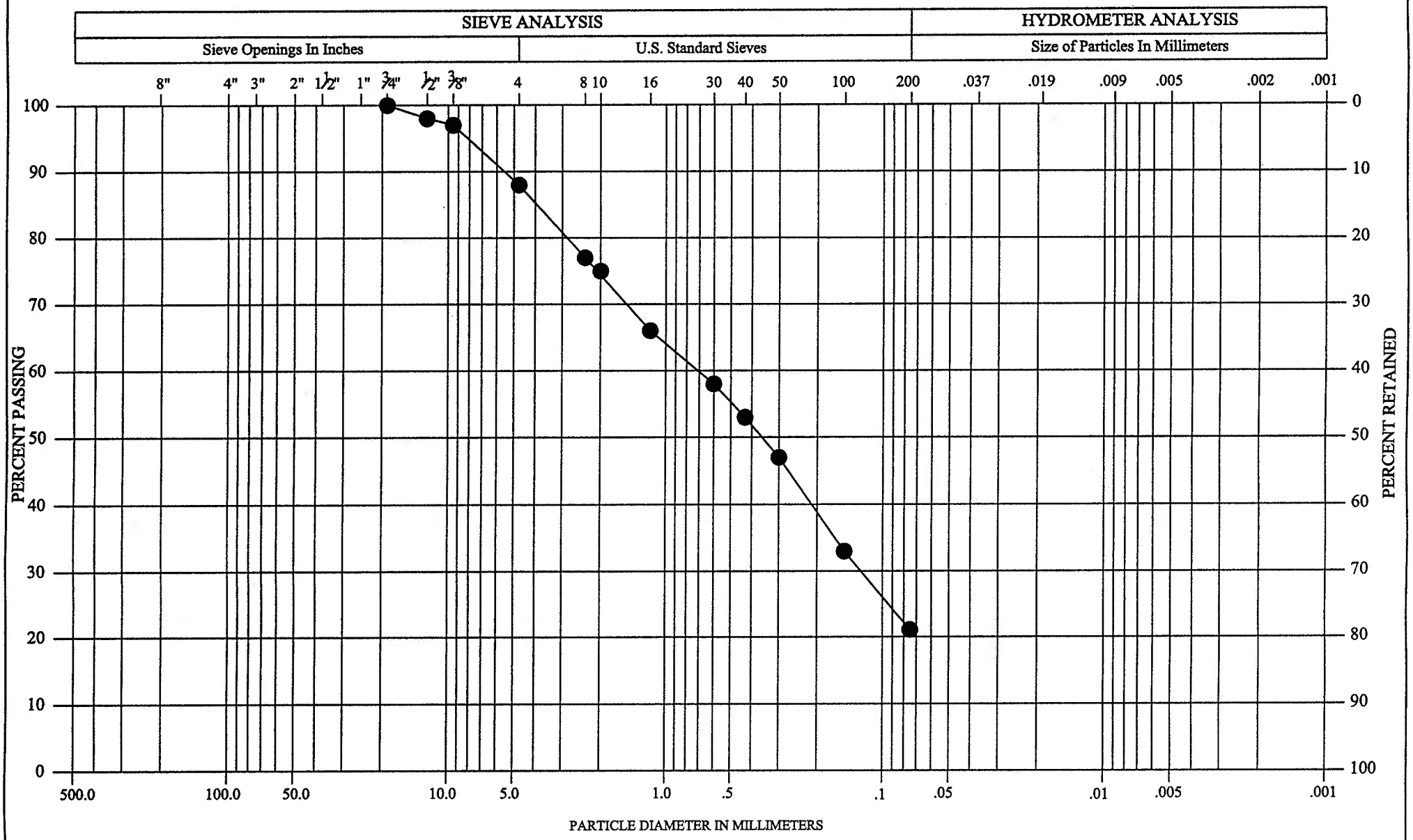

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-1 | Bulk | 1 - 4 | - | 8 | NV | NP | NP | silty SAND with trace gravel, brown<br>SM / A-2-4 (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



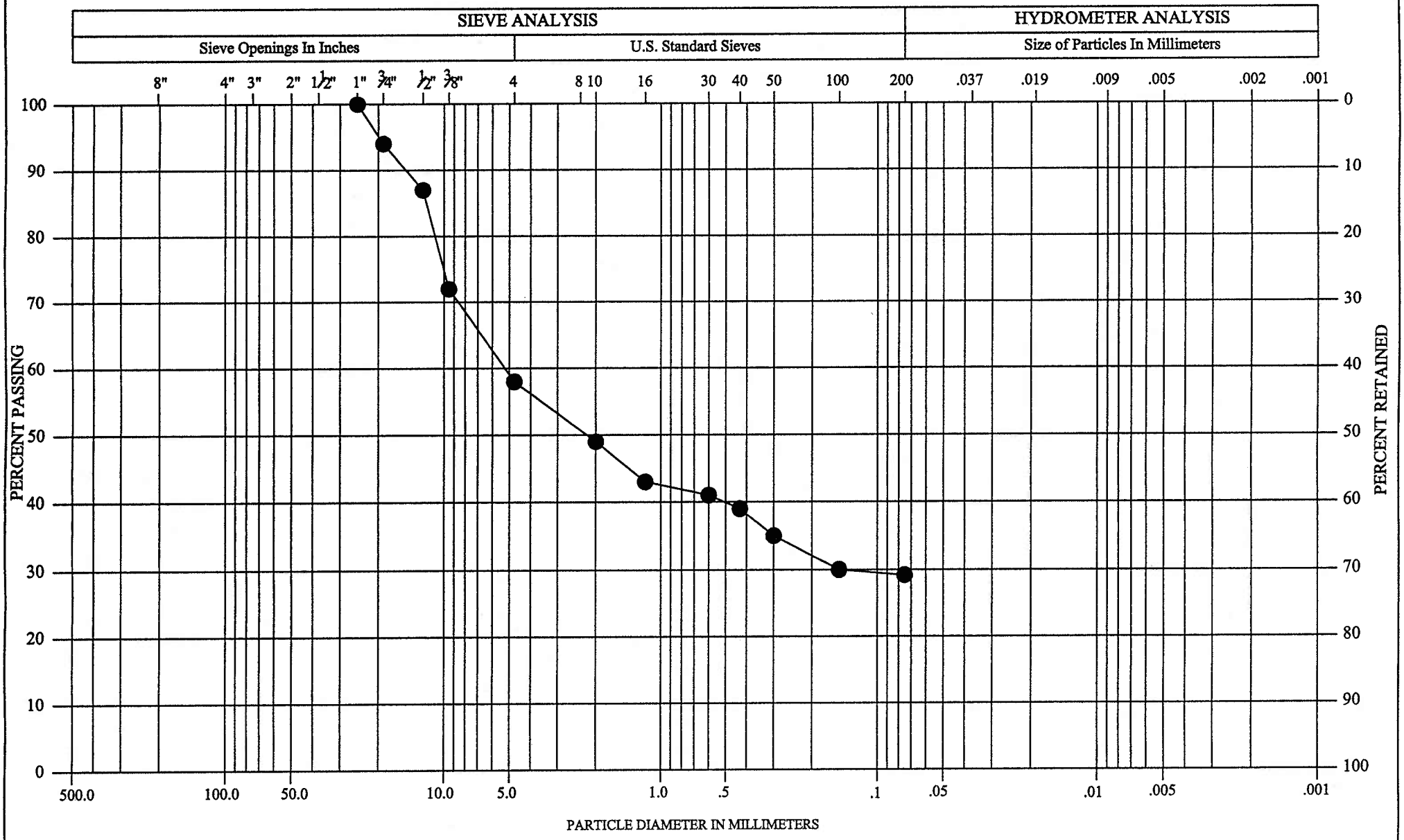

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-2 | Bulk | 1 - 4 | - | 9.8 | NV | NP | NP | silty SAND with trace gravel, brown<br>SM / A-2-4 (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



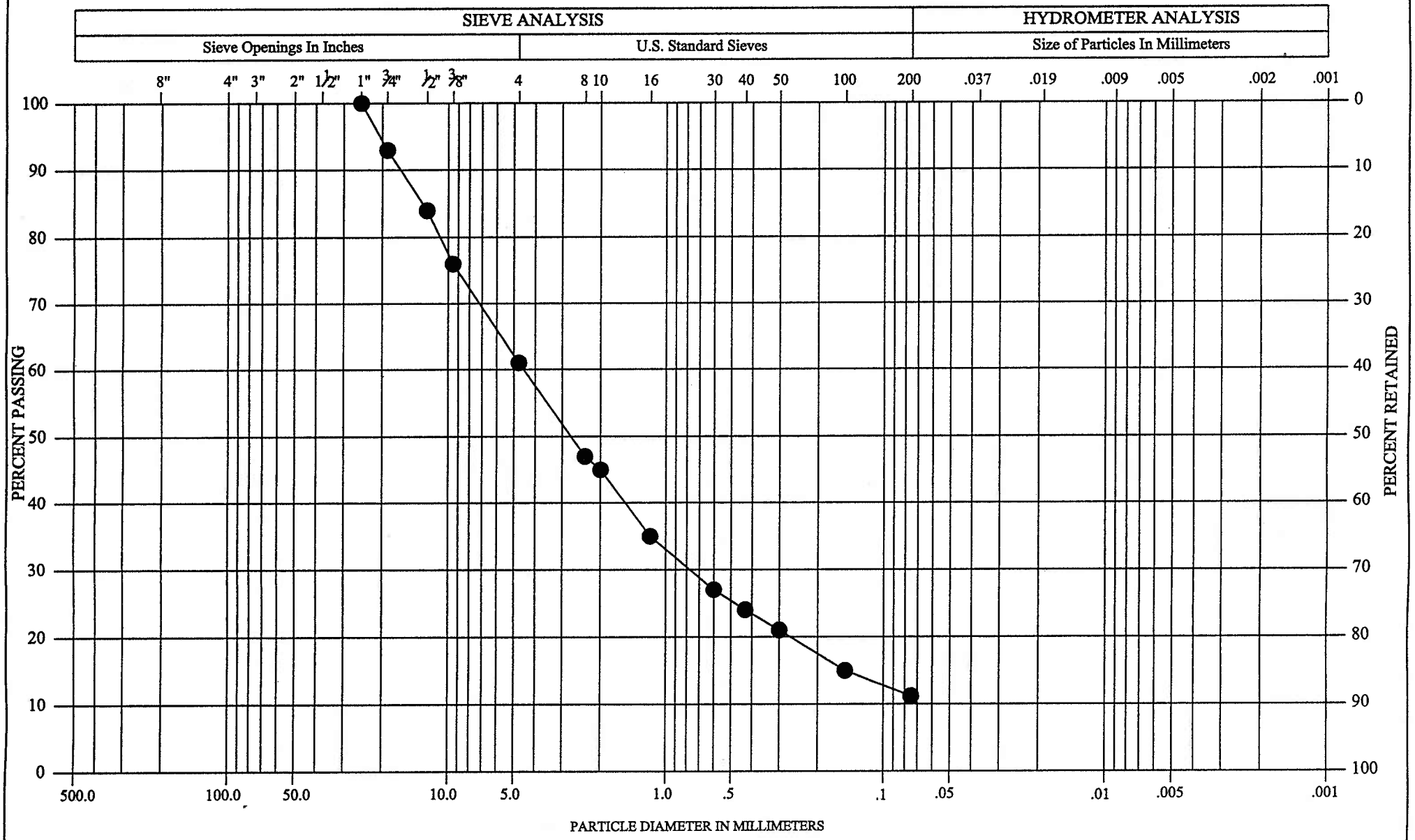

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-3 | Bulk | 1 - 4 | - | 5.7 | NV | NP | NP | silty sandy GRAVEL, yellow brown<br>GM / A-2-4 (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



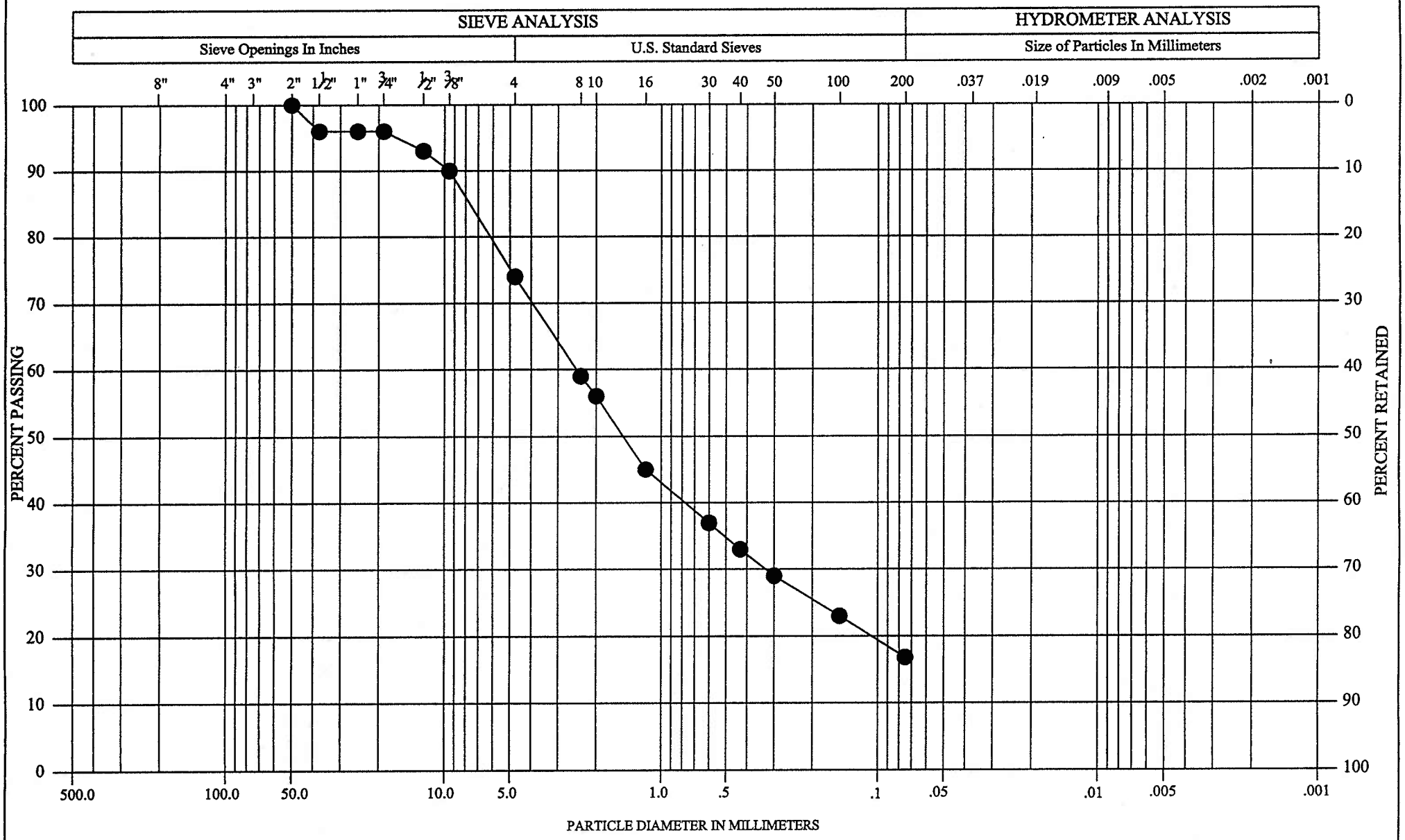

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-4 | Bulk | 1 - 4 | - | 6.7 | NV | NP | NP | gravelly SAND with some silt, brown<br>SP-SM / A-1-a (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



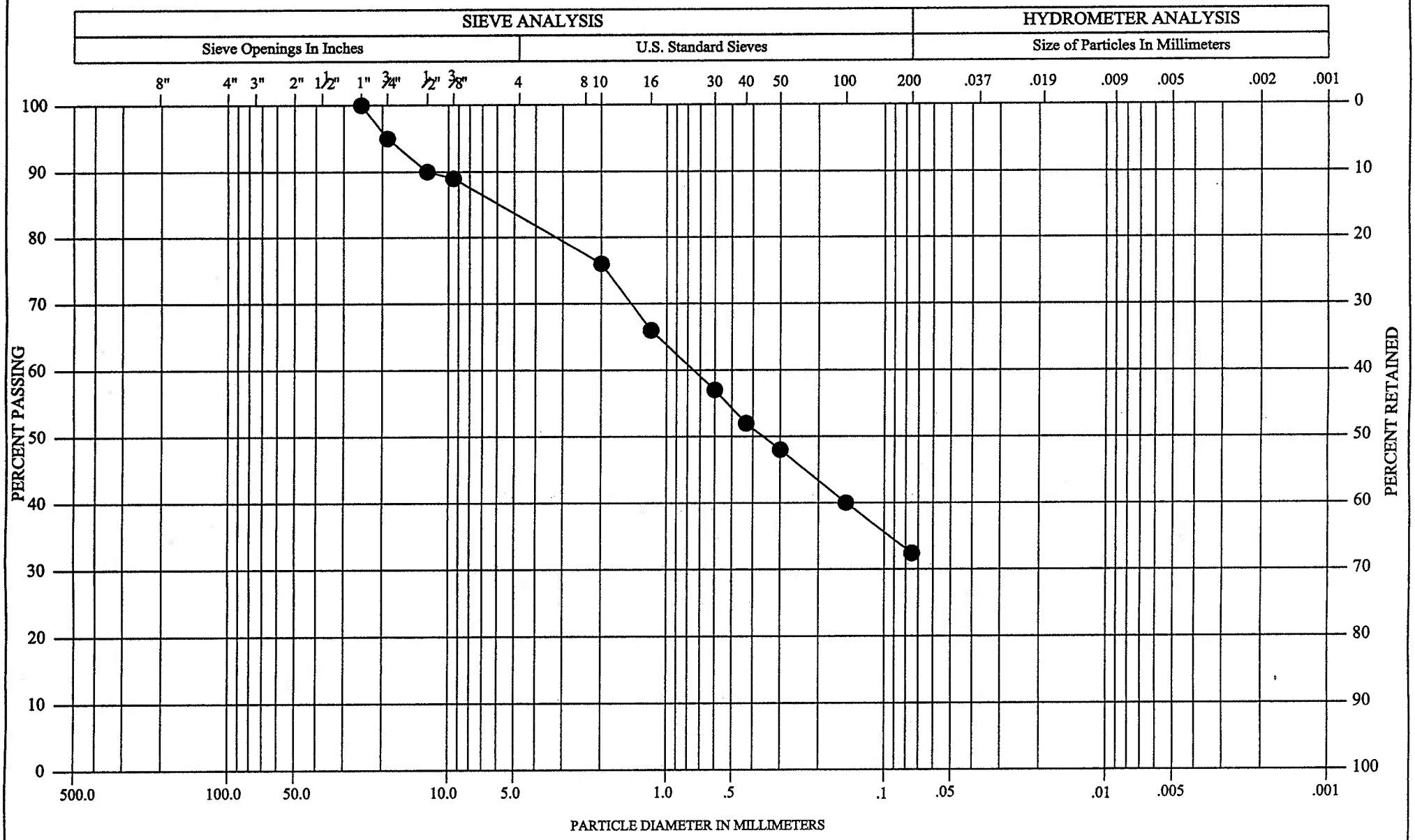

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-5 | Bulk | 1 - 4 | - | 6 | NV | NP | NP | silty SAND with some gravel, brown<br>SM / A-1-b (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



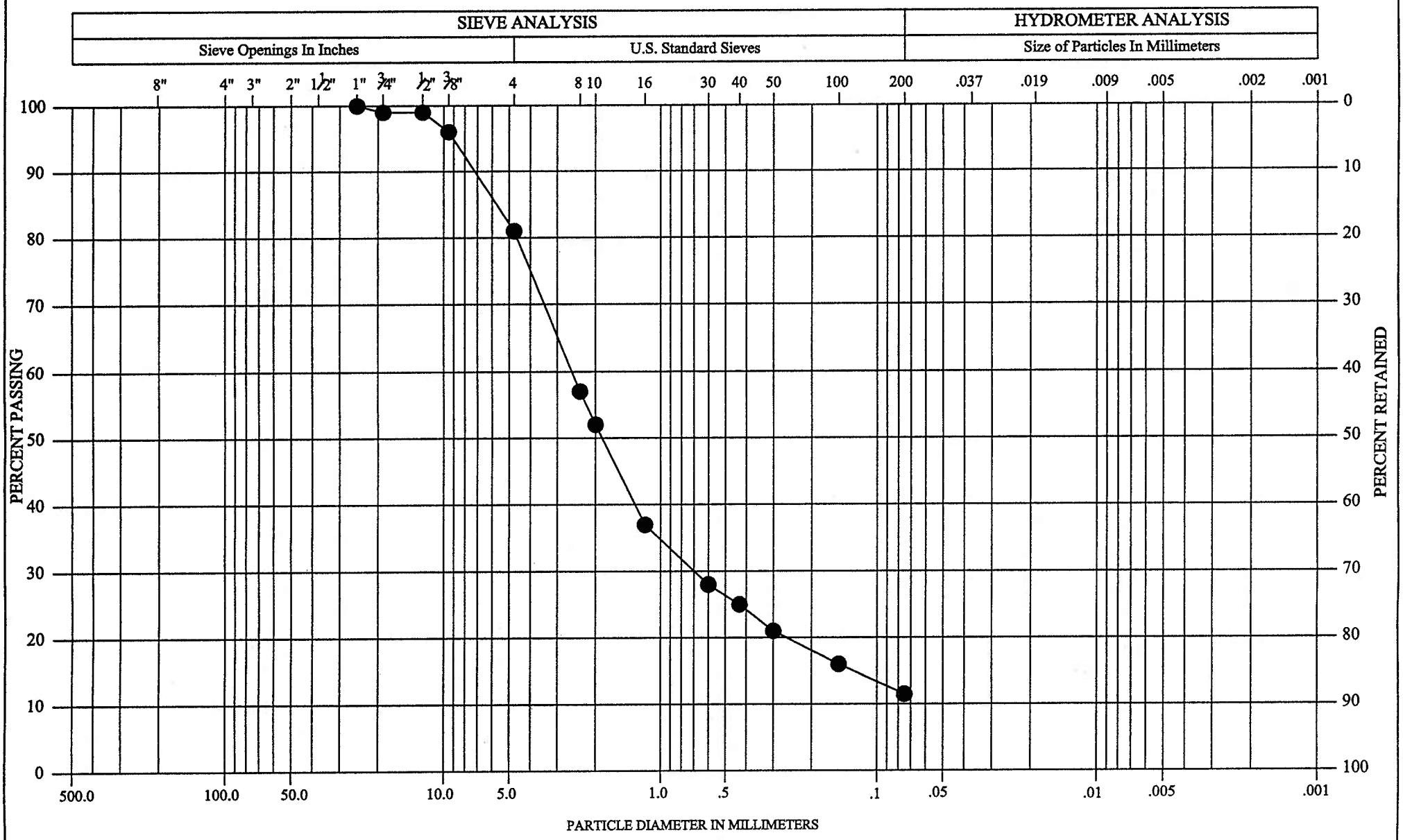

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-6 | SS | 1.5 | - | 8.6 | NV | NP | NP | silty SAND with trace gravel, brown<br>SM / A-2-4 (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A



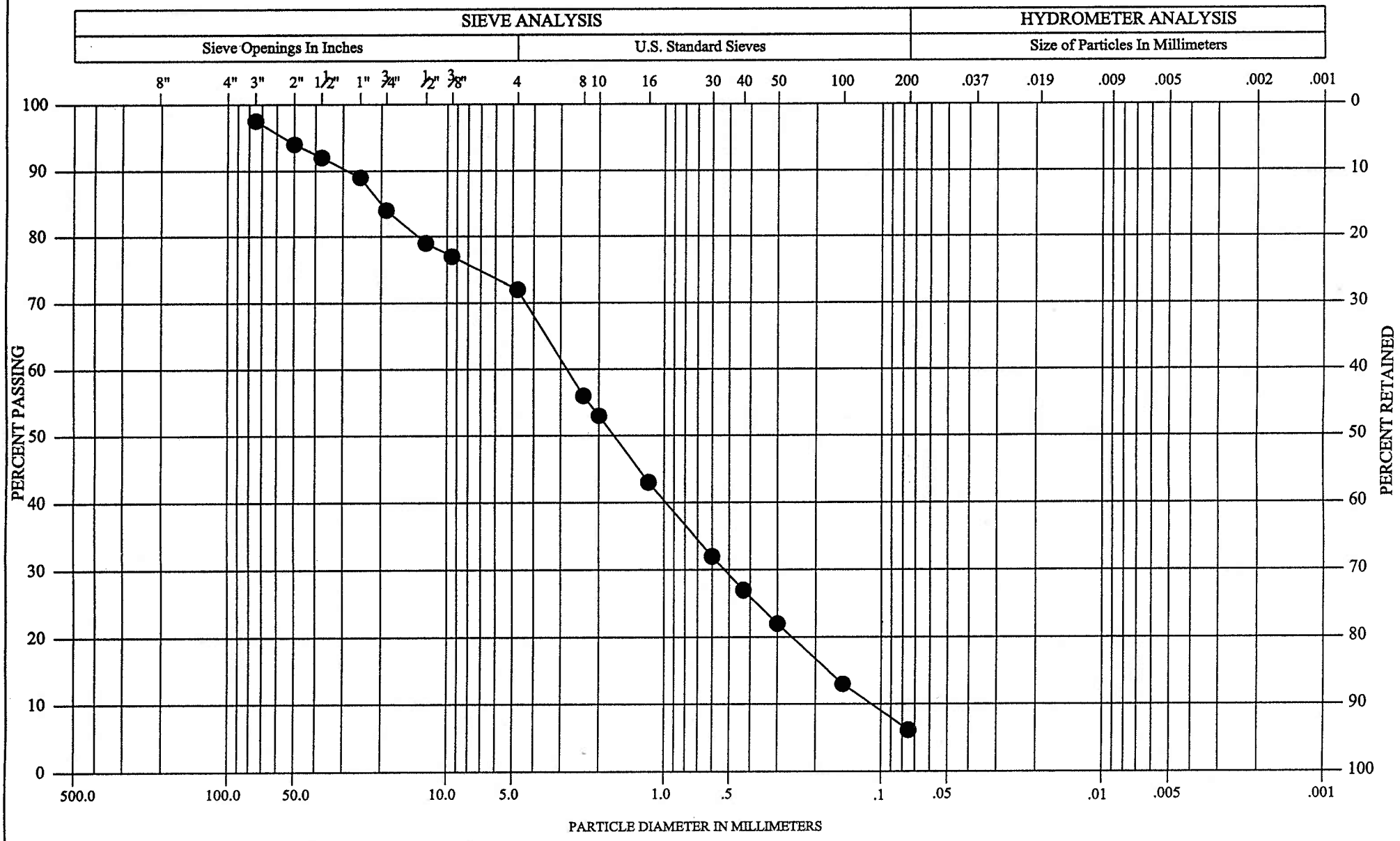

| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| P-7 | Bulk | 1 - 4 | - | 8.2 | NV | NP | NP | SAND with some silt and gravel, brown<br>SP-SM / A-1-b (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A




| BORING NO. | SAMPLE TYPE | SAMPLE DEPTH (FT) | NATURAL DRY DENSITY (PCF) | MOISTURE CONTENT % | LL | PL | PI | SOIL DESCRIPTION/CLASSIFICATION |
|---|---|---|---|---|---|---|---|---|
| - | SS | - | - | 10.8 | NV | NP | NP | SAND with some silt and gravel (Base Coarse)<br>SP-SM / A-1-b (0) |

**YEH & ASSOCIATES, INC.**

GRADATION ANALYSIS

DRAWN BY: BD
CHECKED BY: SY
DATE: 11/19/03

JOB NO.: 23-077
FIGURE: N/A

## R- Value (AASHTO T190)

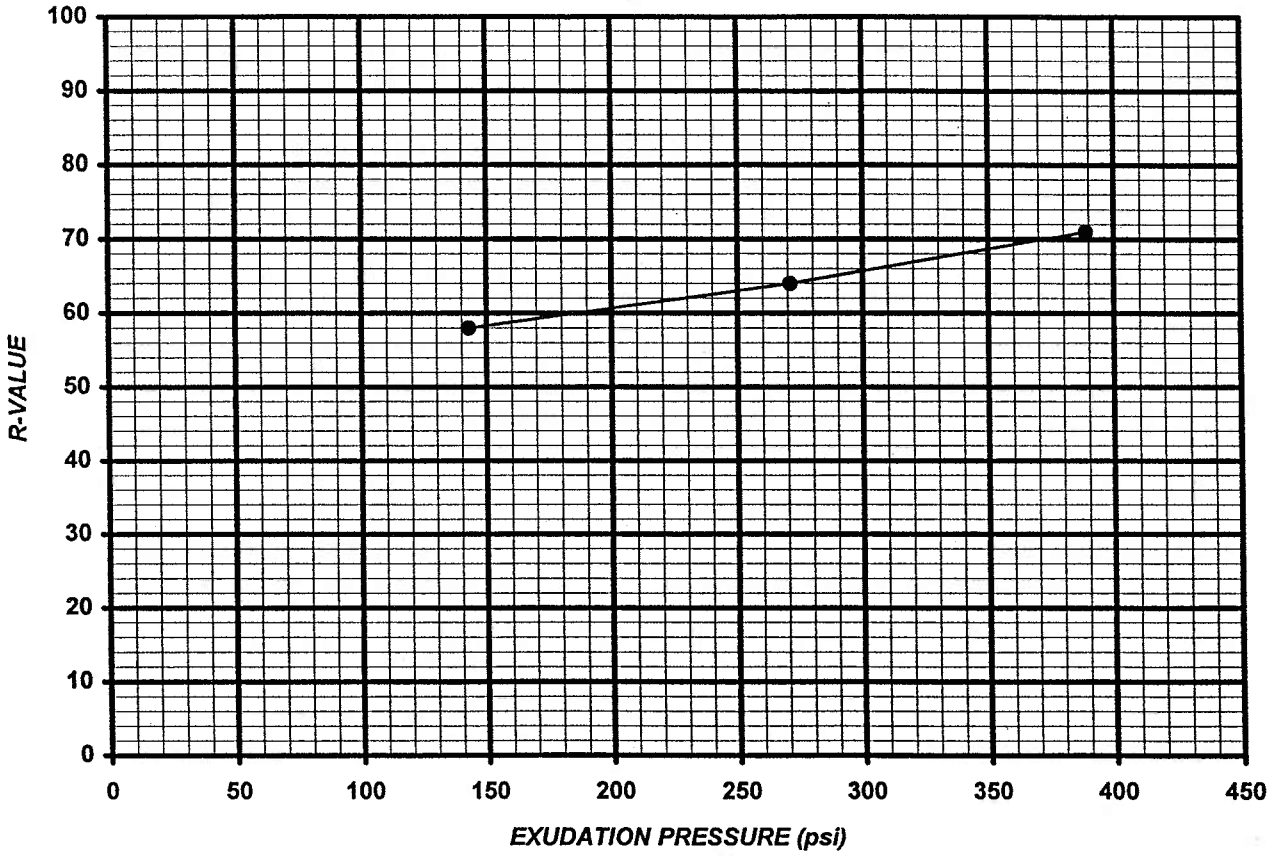
Tested For: Yeh and Associates
2910 S. Tejon Street
Englewood, CO 80110

Project: Laboratory testing

PSI Report No.: 531-30083-14

Date: November 19, 2003

### *HVEEM STABILOMETER TEST RESULTS*




| Test Specimen | 1 | 2 | 3 |
|---|---|---|---|
| Moisture Content (%) | 12.1 | 10.4 | 24.6 |
| Density (pcf) | 113.6 | 117.4 | 103.1 |
| Exudation Pressure (psi) | 143 | 271 | 389 |
| R-Value | 58 | 64 | 71 |

Sample Description: Silty SAND

Project: 23-077 Lake Mary Road
Boring No: Combined P1 @ 1-4', P2 @ 1-4', P3 @ 1.5 - 4'
Sample No: 03-406A
R-Value (300 psi): 66

## R- Value (AASHTO T190)

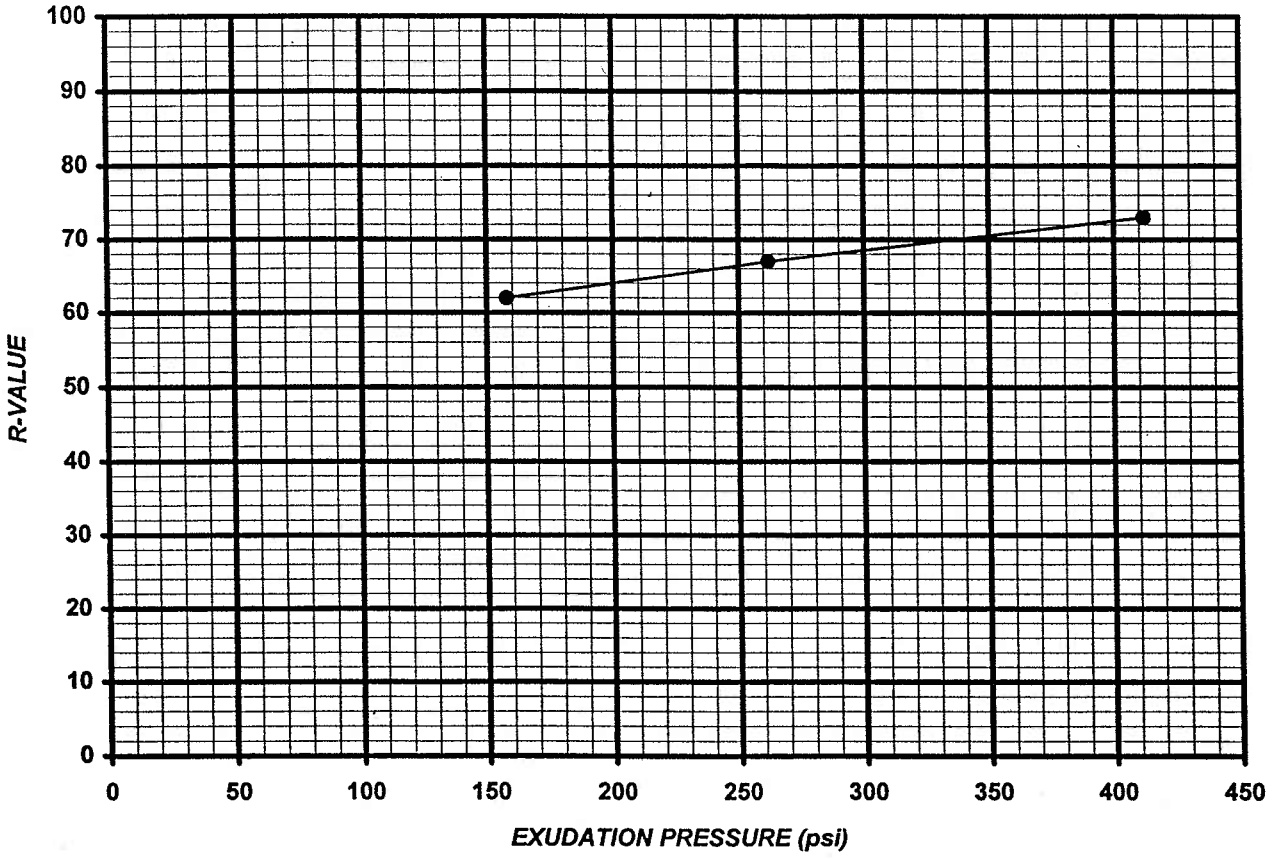
Tested For: Yeh and Associates
2910 S. Tejon Street
Englewood, CO 80110

Project: Laboratory testing

PSI Report No.: 531-30083-14

Date: November 19, 2003

### *HVEEM STABILOMETER TEST RESULTS*




| Test Specimen | 1 | 2 | 3 |
|---|---|---|---|
| Moisture Content (%) | 8.4 | 8.5 | 8.6 |
| Density (pcf) | 133.2 | 131.0 | 127.7 |
| Exudation Pressure (psi) | 158 | 262 | 412 |
| R-Value | 62 | 67 | 73 |

Sample Description: Silty SAND

Project: 23-077 Lake Mary Road
Boring No: P4 S.S. @ 1'
Sample No: 03-409
R-Value (300 psi): 68

## R- Value (AASHTO T190)

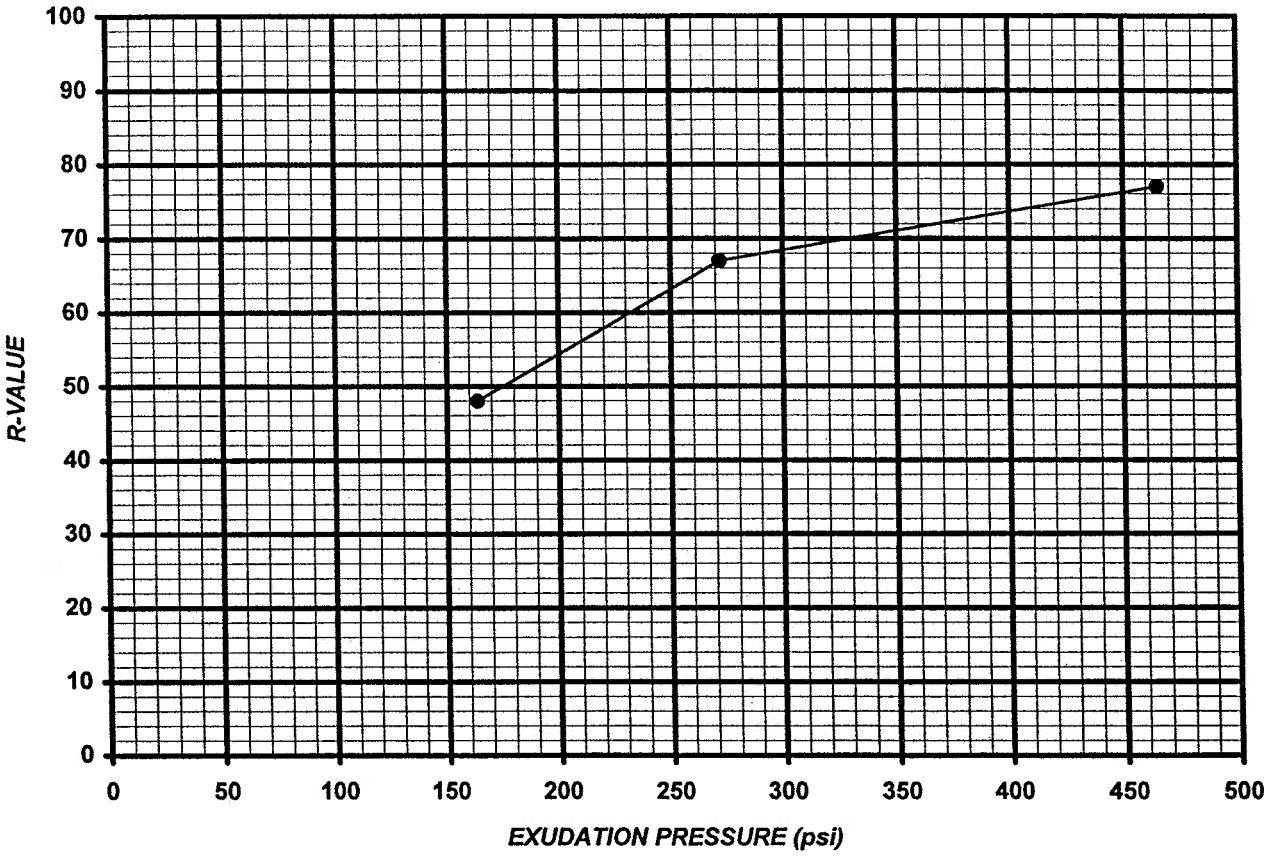
Tested For: Yeh and Associates
2910 S. Tejon Street
Englewood, CO 80110

Project: Laboratory testing

Date: November 19, 2003

PSI Report No.: 531-30083-14

### *HVEEM STABILOMETER TEST RESULTS*




| Test Specimen | 1 | 2 | 3 |
|---|---|---|---|
| Moisture Content (%) | 14.8 | 8.7 | 8.1 |
| Density (pcf) | 123.0 | 132.3 | 131.6 |
| Exudation Pressure (psi) | 164 | 272 | 465 |
| R-Value | 48 | 67 | 77 |

Sample Description: Silty sand

Project: 23-077 Lake Mary Road
Boring No: P7 @1.5 - 4 combined with P5 @1 - 3.5
Sample No: 3411
R-Value (300 psi): 68

## R- Value (AASHTO T190)

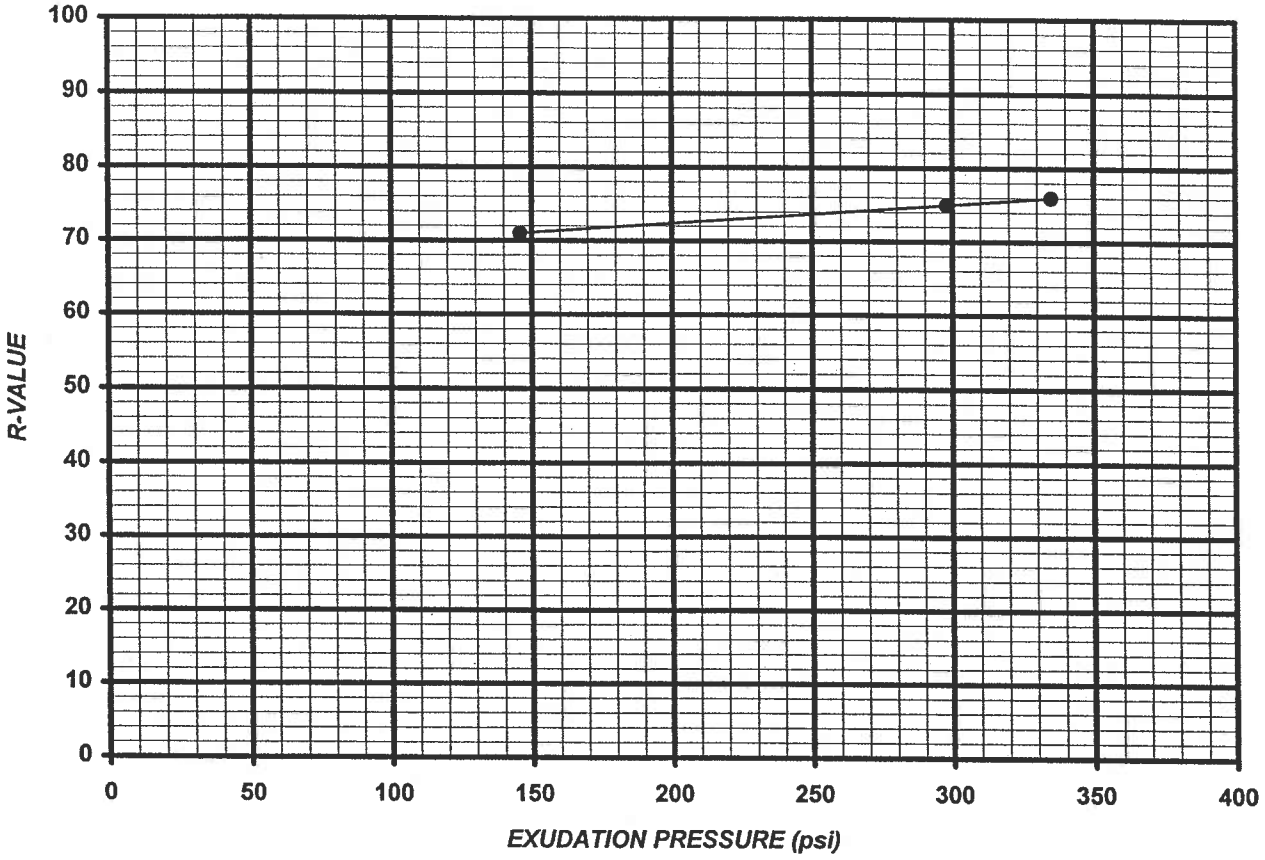
Tested For: Yeh and Associates
2910 S. Tejon Street
Englewood, CO 80110

Project: Laboratory testing

Date: November 19, 2003

PSI Report No.: 531-30083-14

### *HVEEM STABILOMETER TEST RESULTS*




| Test Specimen | 1 | 2 | 3 |
|---|---|---|---|
| Moisture Content (%) | 10.1 | 12.6 | 9.7 |
| Density (pcf) | 119.7 | 114.9 | 117.7 |
| Exudation Pressure (psi) | 335 | 298 | 146 |
| R-Value | 76 | 75 | 71 |

Sample Description: Base Course

Project: 23-077 Lake Mary Road

Sample No: 3406
R-Value (300 psi): 75

# APPENDIX E

**Resilient Modulus M_R**

R-Value= 66

S1=(R-Value-5)/11.29+3

S1= 8.40

M_R=10^((S1+18.72)/6.24)

**M_R= 22214.5**

1993 AASHTO Pavement Design

# DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

## Flexible Structural Design Module

R=66

## Flexible Structural Design

| | |
|---|---|
| 18-kip ESALs Over Initial Performance Period | 46,000 |
| Initial Serviceability | 4.2 |
| Terminal Serviceability | 2 |
| Reliability Level | 75 % |
| Overall Standard Deviation | 0.49 |
| Roadbed Soil Resilient Modulus | 22,215 psi |
| Stage Construction | 1 |
| | |
| Calculated Design Structural Number | 1.19 in |

## Specified Layer Design

| Layer | Material Description | Struct Coef. (Ai) | Drain Coef. (Mi) | Thickness (Di)(in) | Width (ft) | Calculated SN (in) |
|---|---|---|---|---|---|---|
| 1 | HACP | 0.44 | 1 | 3 | 13 | 1.32 |
| 2 | Full Depth Reclamation | 0.12 | 0.9 | 5 | 13 | 0.54 |
| Total | - | - | - | 8.00 | - | 1.86 |

1993 AASHTO Pavement Design

# DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

## Flexible Structural Design Module

R=66

## Flexible Structural Design

| | |
|---|---|
| 18-kip ESALs Over Initial Performance Period | 46,000 |
| Initial Serviceability | 4.2 |
| Terminal Serviceability | 2 |
| Reliability Level | 75 % |
| Overall Standard Deviation | 0.49 |
| Roadbed Soil Resilient Modulus | 22,215 psi |
| Stage Construction | 1 |
| | |
| Calculated Design Structural Number | 1.19 in |

## Specified Layer Design

| Layer | Material Description | Struct Coef. (Ai) | Drain Coef. (Mi) | Thickness (Di)(in) | Width (ft) | Calculated SN (in) |
|---|---|---|---|---|---|---|
| 1 | HACP | 0.44 | 1 | 3 | 13 | 1.32 |
| 2 | Class 6 ABC | 0.14 | 0.9 | 6 | 13 | 0.76 |
| Total | - | - | - | 9.00 | - | 2.08 |

1993 AASHTO Pavement Design

# DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

## Flexible Structural Design Module

Full Depth HACP
R=66

## Flexible Structural Design

| | |
|---|---|
| 18-kip ESALs Over Initial Performance Period | 46,000 |
| Initial Serviceability | 4.2 |
| Terminal Serviceability | 2 |
| Reliability Level | 75 % |
| Overall Standard Deviation | 0.49 |
| Roadbed Soil Resilient Modulus | 22,215 psi |
| Stage Construction | 1 |
| | |
| Calculated Design Structural Number | 1.19 in |

## Specified Layer Design

| Layer | Material Description | Struct Coef. (Ai) | Drain Coef. (Mi) | Thickness (Di)(in) | Width (ft) | Calculated SN (in) |
|---|---|---|---|---|---|---|
| 1 | HACP | 0.44 | 1 | 4 | 13 | 1.76 |
| Total | - | - | - | 4.00 | - | 1.76 |

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Yeh and Associates, Inc.
2910 South Tejon Street
Englewood, CO 80110

## Overlay Design Module

2" Mill/ 2" Overlay

## AC Overlay of AC Pavement

| | |
|---|---|
| Structural Number for Future Traffic | 1.19 in |

| Design Method | Effective Existing Structural Number (in) | Overlay Structural Number (in) |
|---|---|---|
| Component Analysis | 0.75 | 0.44 |
| Remaining Life | - | - |
| Non-Destructive Testing | - | - |

## Structural Number for Future Traffic

| | |
|---|---|
| Future 18-kip ESALs Over Design Period | 46,000 |
| Initial Serviceability | 4.2 |
| Terminal Serviceability | 2 |
| Reliability Level | 75 % |
| Overall Standard Deviation | 0.49 |
| Subgrade Resilient Modulus | 22,215 psi |
| Calculated Structural Number for Future Traffic | 1.19 in |

## Effective Pavement Thickness - Component Analysis Method

| Layer | Material Description | Structural Coefficient | Drainage Coefficient | Thickness (in) |
|---|---|---|---|---|
| 1 | HACP | 0.25 | 1 | 5 |

| | |
|---|---|
| Milling Thickness | 2 in |

Calculated Results

| | |
|---|---|
| Calculated Pavement Structural Number Before Milling | 1.25 in |
| Calculated Effective Pavement Structural Number | 0.75 in |

## Specified Layer Design

| Layer | Material Description | Struct Coef. (Ai) | Drain Coef. (Mi) | Thickness (Di)(in) | Width (ft) | Calculated SN (in) |
|---|---|---|---|---|---|---|
| 1 | HACP | 0.44 | 1 | 2 | 13 | 0.88 |
| Total | - | - | - | 2.00 | - | 0.88 |

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## Life Cycle Cost Module

R66 3 HACP + 5" Reclamation

## Life Cycle Cost Data

## Summary

| | |
|---|---|
| Analysis Period | 20 years |
| Project Length | 2.8 mi |
| Discount Rate | 4 % |
| Number of Lanes in One Direction | 1 |
| Type of Roadway | Undivided |

Total Costs -- Using NPV on a basis of total costs for both directions

| | |
|---|---|
| Initial Construction Cost | $498,498 |
| Rehabilitation Cost | - |
| Salvage Value | - |
| Total Cost | $498,498 |

## Initial Construction

3" HACP + 5" Reclamation

| | |
|---|---|
| Construction Year | 2005 |
| Performance Period | 20 years |

Cost Information -- Using NPV on a basis of total costs for both directions

| Information Type | Source | Costs at Year of Construction (One Direction) | Net Costs |
|---|---|---|---|
| Construction | DARWin Calculated | $249,249.00 | $498,498.00 |
| Maintenance | DARWin Calculated | $0.00 | $0.00 |
| Total | - | $249,249.00 | $498,498.00 |

## Salvage Values

| | |
|---|---|
| Salvage Year | 2025 |

Cost Information -- Using NPV on a basis of total costs for both directions*

| Phase | Description | Source | Salvage Value | Net Value |
|---|---|---|---|---|
| Initial Construction | - | DARWin Calculated | $0.00 | $0.00* |

*Note: These values are not represented by the inputs or an error occurred in calculation.

## Initial Construction Maintenance Costs

| | |
|---|---|
| Year Maintenance Costs Begin | 2006 |
| Annual Maintenance Costs | $0.00 per lane mi |
| Annual Increase in Maintenance Costs | 0 % |

Calculated Non Discounted Maintenance Costs (One Direction) $0.00 *

*Note: This value is not represented by the inputs or an error occurred in calculation.

## Initial Construction Pay Items

| Name | Lane | Layer | Unit | Unit Cost | Quantity | Total Cost |
|---|---|---|---|---|---|---|
| FHWA-HACP | T.L. | 1 | ton | $40.00 | 3,483 | $139,339.20 |
| FHWA- Liquid Asphalt | T.L. | 2 | ton | $250.00 | 209 | $52,252.20 |
| FHWA-FDR | T.L. | 3 | sq ft | $0.30 | 192,192 | $57,657.60 |

Non Discounted Costs (One Direction)

| | |
|---|---|
| Traffic Lane | $249,249.00 |
| Inner Shoulder | $0.00 |
| Outer Shoulder | $0.00 |
| Miscellaneous | $0.00 |
| Total Non Discounted Cost (One Direction) | $249,249.00 |

## Initial Construction -- Traffic Lane Dimensions

| Layer | Material Description | Width (ft) | Thickness (in) |
|---|---|---|---|
| 1 | FHWA-HACP | 13 | 3 |
| 2 | FHWA- Liquid Asphalt | 13 | 3 |
| 3 | FHWA-FDR | 13 | 5 |

## Initial Construction -- Inner Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

## Initial Construction -- Outer Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

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## Life Cycle Cost Module

R66 3 HACP + 6" ABC

## Life Cycle Cost Data

## Summary

| | |
|---|---|
| Analysis Period | 20 years |
| Project Length | 2.8 mi |
| Discount Rate | 4 % |
| Number of Lanes in One Direction | 1 |
| Type of Roadway | Undivided |

Total Costs -- Using NPV on a basis of total costs for both directions

| | |
|---|---|
| Initial Construction Cost | $603,541 |
| Rehabilitation Cost | - |
| Salvage Value | - |
| Total Cost | $603,541 |

## Initial Construction

3" HACP + 6" ABC

| | |
|---|---|
| Construction Year | 2005 |
| Performance Period | 20 years |

Cost Information -- Using NPV on a basis of total costs for both directions

| Information Type | Source | Costs at Year of Construction (One Direction) | Net Costs |
|---|---|---|---|
| Construction | DARWin Calculated | $301,770.39 | $603,540.78 |
| Maintenance | DARWin Calculated | $0.00 | $0.00 |
| Total | - | $301,770.39 | $603,540.78 |

## Salvage Values

Salvage Year 2025

Cost Information -- Using NPV on a basis of total costs for both directions*

| Phase | Description | Source | Salvage Value | Net Value |
|---|---|---|---|---|
| Initial Construction | - | DARWin Calculated | $0.00 | $0.00* |

*Note: These values are not represented by the inputs or an error occurred in calculation.

## Initial Construction Maintenance Costs

| | |
|---|---|
| Year Maintenance Costs Begin | 2006 |
| Annual Maintenance Costs | $0.00 per lane mi |
| Annual Increase in Maintenance Costs | 0 % |

Calculated Non Discounted Maintenance Costs (One Direction) $0.00 *

*Note: This value is not represented by the inputs or an error occurred in calculation.

## Initial Construction Pay Items

| Name | Lane | Layer | Unit | Unit Cost | Quantity | Total Cost |
|---|---|---|---|---|---|---|
| FHWA-HACP | T.L. | 1 | ton | $40.00 | 3,483 | $139,339.20 |
| FHWA- Liquid Asphalt | T.L. | 2 | ton | $250.00 | 209 | $52,252.20 |
| ABC (Class 6) | T.L. | 3 | ton | $13.00 | 6,390 | $83,074.99 |
| Milling - FHWA | T.L. | 4 | sq yd | $1.50 | 18,069 | $27,104.00 |

Non Discounted Costs (One Direction)

| | |
|---|---|
| Traffic Lane | $301,770.39 |
| Inner Shoulder | $0.00 |
| Outer Shoulder | $0.00 |
| Miscellaneous | $0.00 |
| Total Non Discounted Cost (One Direction) | $301,770.39 |

## Initial Construction -- Traffic Lane Dimensions

| Layer | Material Description | Width (ft) | Thickness (in) |
|---|---|---|---|
| 1 | FHWA-HACP | 13 | 3 |
| 2 | FHWA- Liquid Asphalt | 13 | 3 |
| 3 | ABC (Class 6) | 13 | 6 |
| 4 | Milling - FHWA | 11 | 5 |

## Initial Construction -- Inner Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

## Initial Construction -- Outer Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

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# DARWin Pavement Design and Analysis System

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## Life Cycle Cost Module

R66 4 HACP

## Life Cycle Cost Data

## Summary

| | |
|---|---|
| Analysis Period | 20 years |
| Project Length | 2.8 mi |
| Discount Rate | 4 % |
| Number of Lanes in One Direction | 1 |
| Type of Roadway | Undivided |

Total Costs -- Using NPV on a basis of total costs for both directions

| | |
|---|---|
| Initial Construction Cost | $565,118 |
| Rehabilitation Cost | - |
| Salvage Value | - |
| Total Cost | $565,118 |

## Initial Construction

4" HACP

| | |
|---|---|
| Construction Year | 2005 |
| Performance Period | 20 years |

Cost Information -- Using NPV on a basis of total costs for both directions

| Information Type | Source | Costs at Year of Construction (One Direction) | Net Costs |
|---|---|---|---|
| Construction | DARWin Calculated | $282,559.20 | $565,118.40 |
| Maintenance | DARWin Calculated | $0.00 | $0.00 |
| Total | - | $282,559.20 | $565,118.40 |

## Salvage Values

Salvage Year 2025

Cost Information -- Using NPV on a basis of total costs for both directions*

| Phase | Description | Source | Salvage Value | Net Value |
|---|---|---|---|---|
| Initial Construction | - | DARWin Calculated | $0.00 | $0.00* |

*Note: These values are not represented by the inputs or an error occurred in calculation.

## Initial Construction Maintenance Costs

| | |
|---|---|
| Year Maintenance Costs Begin | 2006 |
| Annual Maintenance Costs | $0.00 per lane mi |
| Annual Increase in Maintenance Costs | 0 % |

Calculated Non Discounted Maintenance Costs (One Direction) $0.00 *

*Note: This value is not represented by the inputs or an error occurred in calculation.

## Initial Construction Pay Items

| Name | Lane | Layer | Unit | Unit Cost | Quantity | Total Cost |
|---|---|---|---|---|---|---|
| FHWA-HACP | T.L. | 1 | ton | $40.00 | 4,645 | $185,785.60 |
| FHWA- Liquid Asphalt | T.L. | 2 | ton | $250.00 | 279 | $69,669.60 |
| Milling - FHWA | T.L. | 3 | sq yd | $1.50 | 18,069 | $27,104.00 |

Non Discounted Costs (One Direction)

| | |
|---|---|
| Traffic Lane | $282,559.20 |
| Inner Shoulder | $0.00 |
| Outer Shoulder | $0.00 |
| Miscellaneous | $0.00 |
| Total Non Discounted Cost (One Direction) | $282,559.20 |

## Initial Construction -- Traffic Lane Dimensions

| Layer | Material Description | Width (ft) | Thickness (in) |
|---|---|---|---|
| 1 | FHWA-HACP | 13 | 4 |
| 2 | FHWA- Liquid Asphalt | 13 | 4 |
| 3 | Milling - FHWA | 11 | 5 |

## Initial Construction -- Inner Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

## Initial Construction -- Outer Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

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## Life Cycle Cost Module

2" overlay

## Life Cycle Cost Data

## Summary

| | |
|---|---|
| Analysis Period | 20 years |
| Project Length | 2.8 mi |
| Discount Rate | 4 % |
| Number of Lanes in One Direction | 1 |
| Type of Roadway | Undivided |

Total Costs -- Using NPV on a basis of total costs for both directions

| | |
|---|---|
| Initial Construction Cost | $309,663 |
| Rehabilitation Cost | - |
| Salvage Value | - |
| Total Cost | $309,663 |

## Initial Construction

2" HACP overlay

| | |
|---|---|
| Construction Year | 2005 |
| Performance Period | 20 years |

Cost Information -- Using NPV on a basis of total costs for both directions

| Information Type | Source | Costs at Year of Construction (One Direction) | Net Costs |
|---|---|---|---|
| Construction | DARWin Calculated | $154,831.60 | $309,663.20 |
| Maintenance | DARWin Calculated | $0.00 | $0.00 |
| Total | - | $154,831.60 | $309,663.20 |

## Salvage Values

Salvage Year 2025

Cost Information -- Using NPV on a basis of total costs for both directions*

| Phase | Description | Source | Salvage Value | Net Value |
|---|---|---|---|---|
| Initial Construction | - | DARWin Calculated | $0.00 | $0.00* |

*Note: These values are not represented by the inputs or an error occurred in calculation.

## Initial Construction Maintenance Costs

| | |
|---|---|
| Year Maintenance Costs Begin | 2006 |
| Annual Maintenance Costs | $0.00 per lane mi |
| Annual Increase in Maintenance Costs | 0 % |

Calculated Non Discounted Maintenance Costs (One Direction) $0.00 *

*Note: This value is not represented by the inputs or an error occurred in calculation.

## Initial Construction Pay Items

| Name | Lane | Layer | Unit | Unit Cost | Quantity | Total Cost |
|---|---|---|---|---|---|---|
| FHWA-HACP | T.L. | 1 | ton | $40.00 | 2,322 | $92,892.80 |
| FHWA- Liquid Asphalt | T.L. | 2 | ton | $250.00 | 139 | $34,834.80 |
| Milling - FHWA | T.L. | 3 | sq yd | $1.50 | 18,069 | $27,104.00 |

Non Discounted Costs (One Direction)

| | |
|---|---|
| Traffic Lane | $154,831.60 |
| Inner Shoulder | $0.00 |
| Outer Shoulder | $0.00 |
| Miscellaneous | $0.00 |
| Total Non Discounted Cost (One Direction) | $154,831.60 |

## Initial Construction -- Traffic Lane Dimensions

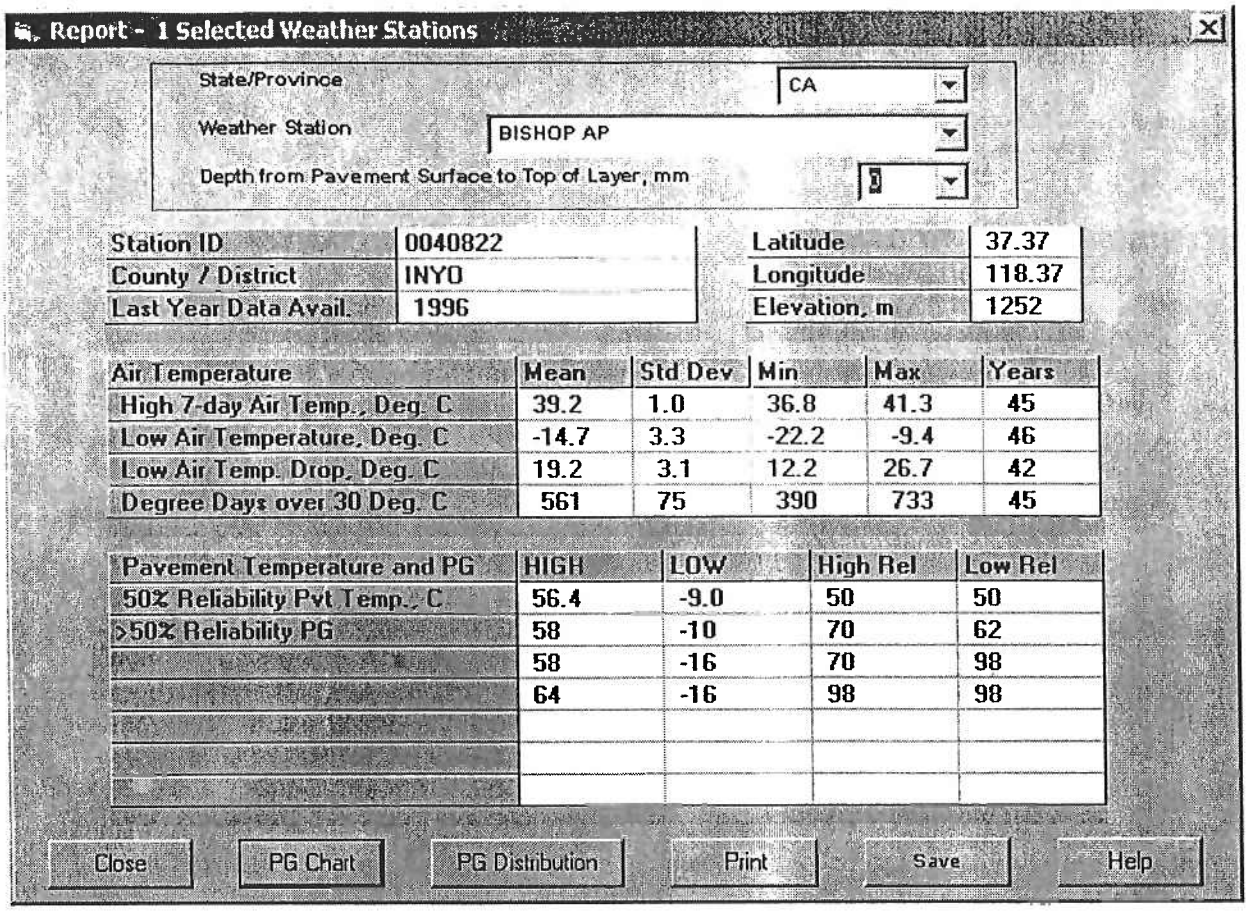
| Layer | Material Description | Width (ft) | Thickness (in) |
|---|---|---|---|
| 1 | FHWA-HACP | 13 | 2 |
| 2 | FHWA- Liquid Asphalt | 13 | 2 |
| 3 | Milling - FHWA | 11 | 2 |

## Initial Construction -- Inner Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|

## Initial Construction -- Outer Shoulder Dimensions

| Layer | Material Description | Width (ft) | Inner Thickness (in) | Outer Thickness (in) |
|---|---|---|---|---|


Report - 1 Selected Weather Stations
State/Province
CA
Weather Station
BISHOP AP
Depth from Pavement Surface to Top of Layer, mm
0
Station ID
0040822
County / District
INYO
Last Year Data Avail.
1996
Latitude
37.37
Longitude
118.37
Elevation, m
1252
Air Temperature
Mean
Std Dev
Min
Max
Years
High 7-day Air Temp., Deg. C
39.2
1.0
36.8
41.3
45
Low Air Temperature, Deg. C
-14.7
3.3
-22.2
-9.4
46
Low Air Temp. Drop, Deg. C
19.2
3.1
12.2
26.7
42
Degree Days over 30 Deg. C
561
75
390
733
45
Pavement Temperature and PG
HIGH
LOW
High Rel
Low Rel
50% Reliability Pvt Temp., C
56.4
-9.0
50
50
>50% Reliability PG
58
-10
70
62
58
-16
70
98
64
-16
98
98
Close
PG Chart
PG Distribution
Print
Save
Help

Carter Burgess

707 17th Street, Suite 2300, Denver, Colorado 80202 (303) 820-5240

# LETTER OF TRANSMITTAL

**Project:** Lake Mary Road **Date:** April 15, 2004

**To:** FHWA- Central Federal Lands Highway Division
555 Zang St, Room 259
Lakewood, CO

**Attn:** Bernardo Bustamante, P.E., Project Manager

**Ref:** Final Pavement Reports

| Item | Qty. | Date | Description |
|---|---|---|---|
| 1 | 3 | 4/15/04 | Final Pavement Report (Lake Mary Rd) |
| | | | |
| | | | |
| | | | |

- [ ] For your approval
- [ ] For your information
- [ ] For your review and comment
- [ ] Other:
- [ ] For your signature
- [X] As you requested
- [ ] Please return

**REMARKS:** **Bernardo,**

**Enclosed are 3 copies of the Final version of the Pavement report.**

**Jeanette Lostracco**

**Signed:** Jeanette Lostracco

**Copies:** Rick West, Dennis Eden, project file

**Via:** US Mail

H:\Templates\Letter of Transmittal.doc